

NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION
WASHINGTON, D.C

CONTRACTOR FINAL REPORT

TEST #

66

66 AFS

DOT HS-803 788

IMPACT TEST OF COMPACT VEHICLE WITH MODIFIED SIDE STRUCTURE, 35 mph, 60° IMPACT, IMPALA-TO-VOLARE, TEST NO. 10

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**Contract No. DOT HS-5-01104
Contract Amt. \$114,805**



**JANUARY 1979
FINAL REPORT**

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Washington, D.C. 20590**

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16. Abstract <p>Test No. 5 of 11 tests conducted to investigate and improve crashworthiness of compact vehicle side structures. This test was run at 35 mph at a striking angle of 60°. A 1975 Ford Torino was the bullet vehicle and a modified 1976 Plymouth Volare the target vehicle.</p> <p>Volare modifications included a heavier door beam, stronger beam-to-door connections, and tying the door structure into the sill. The modified vehicle showed significant improvement in intrusion and door velocity as compared to baseline tests.</p>			
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METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
AREA				
m ²	square inches	6.5	square centimeters	cm ²
ft ²	square feet	0.09	square meters	m ²
yd ²	square yards	0.8	square meters	m ²
m ²	square miles	2.6	square kilometers	km ²
	acres	0.4	hectares	ha
MASS (weight)				
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
VOLUME				
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft ³	cubic feet	0.03	cubic meters	m ³
yd ³	cubic yards	0.76	cubic meters	m ³
TEMPERATURE (exact)				
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
LENGTH				
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
AREA				
cm ²	square centimeters	0.16	square inches	in ²
m ²	square meters	1.2	square yards	yd ²
km ²	square kilometers	0.4	square miles	mi ²
ha	hectares (10 000 m ²)	2.5	acres	ac
MASS (weight)				
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	st
VOLUME				
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m ³	cubic meters	35	cubic feet	ft ³
m ³	cubic meters	1.3	cubic yards	yd ³
TEMPERATURE (exact)				
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

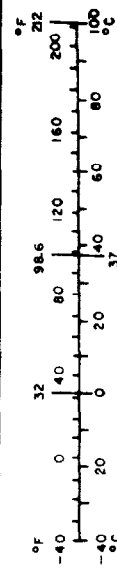


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TEST OBJECTIVE

The test reported herein is No. 5 in the test matrix shown on the following page. This test is part of a program aimed at evaluating the improvement in side impact crashworthiness of a compact size production automobile incorporating improved front door structural characteristics. The bullet car is a 1975 Torino for the first nine tests and a 1978 Impala for the last two tests. The target car is a 1976 4-door Plymouth Volare in all cases. The impact height of the bullet car is the same in all cases except for Test No. 2 where the heights were adjusted to ensure sill engagement.

The entire program consisted of eleven crash tests and one crush test.

TEST MATRIX

Test No.	Bullet Car		Target Car				
	Make	Nominal Impact Speed (mph)	Make	Orientation*	Impacted Side	Interior Padding	Comments
				(deg)			
1	1975 Torino	25	1976 Volare unmodified	60	Right	No	60° Baseline at 25 mph
2	1975 Torino	25	1976 Volare unmodified	60	Left	No	Car heights adjusted to ensure sill engagement
3	1975 Torino	25	1976 Volare w/modified Right front door	60	Right	No	
4	1975 Torino	35	1976 Volare w/modified Left front door	90	Left	No	
5	1975 Torino	35	1976 Volare w/modified Right front door	60	Right	No	Same as No. 3 but higher impact speed
6	1975 Torino	35	1976 Volare w/modified Right front door	60	Right	Yes	Same as No. 5 with interior padding added
7	1975 Torino	35	1976 Volare w/modified Right front door	60	Right	Yes	Replica of No. 6
8	1975 Torino	35	1976 Volare w/modified Left front door	90	Left	Yes	Same as No. 4 with interior padding added
9	1975 Torino	35	1976 Volare unmodified	90	Left	No	90° Baseline at 35 mph
10	1978 Impala	35	1976 Volare w/modified Right front door	60	Right	Yes	Same as No. 6 but with different bullet car
11	1978 Impala	35	1976 Volare w/modified Left front door	90	Left	Yes	Same as No. 8 but with different bullet car

*With respect to Bullet Car line of travel.

Figure 1 shows several views of the production Volare door structure. Figure 2 provides several views of the door as modified for this program. These modifications include the following:

1. Depth of the door beam hat sections was increased.
2. The modified door beam was closed on one side with sheet metal as reinforcement.
3. The beam tie-in at either end was strengthened.
4. The beam was lowered approximately three inches.
5. Tabs were added to the bottom of the door to lock the sill in with the door.
6. Joints in the sheet metal facing inside the door were continuously welded.
7. Nuts were placed on the door hinges.

A drawing of the modified door beam is shown in Figure 3.

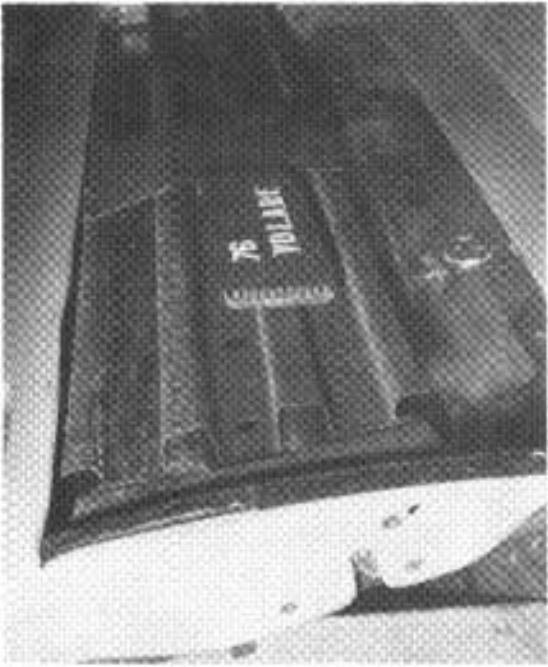
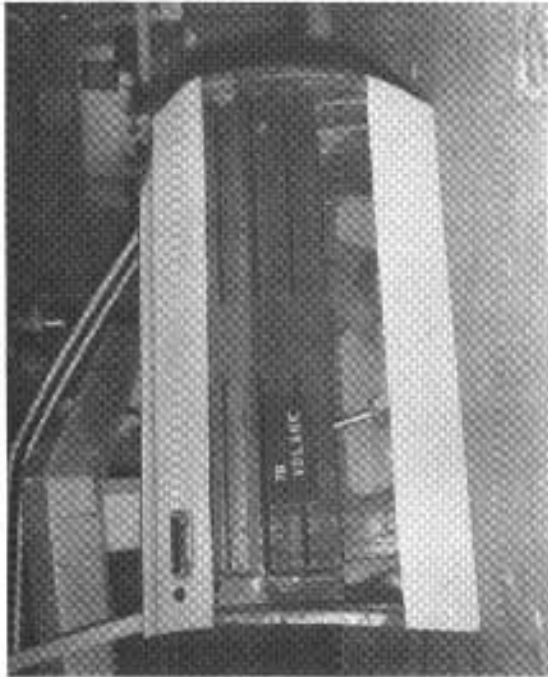
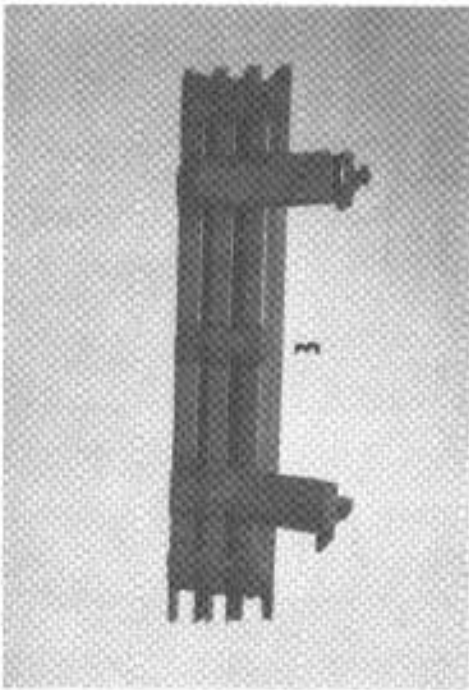
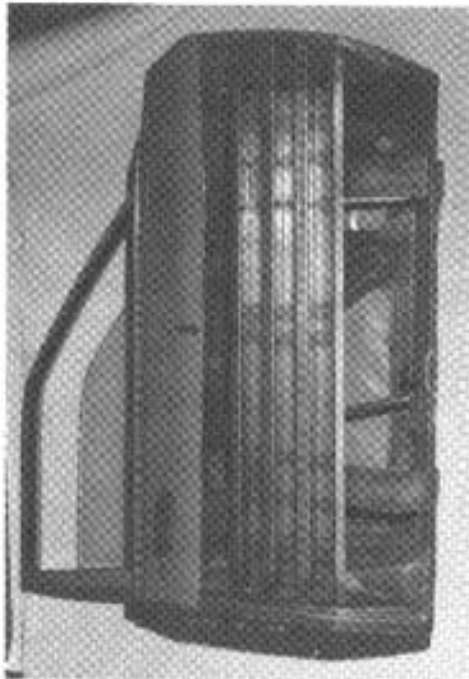


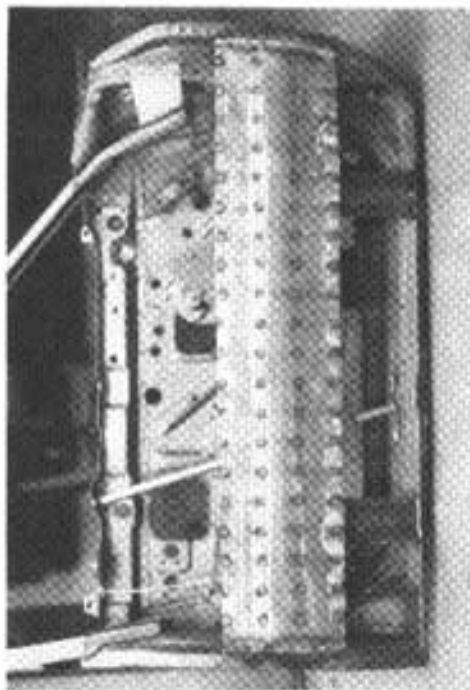
Figure 1. 1976 Volare Door Beam Structure.



Beam Prior to Installation.



Beam Prior to Cover Installation.



Door Beam After Cover Spot-Welded
In Place



Beam and Tabs (Close-up)

Figure 2. 1976 Volare Completed Door Structure as Modified for this Program.

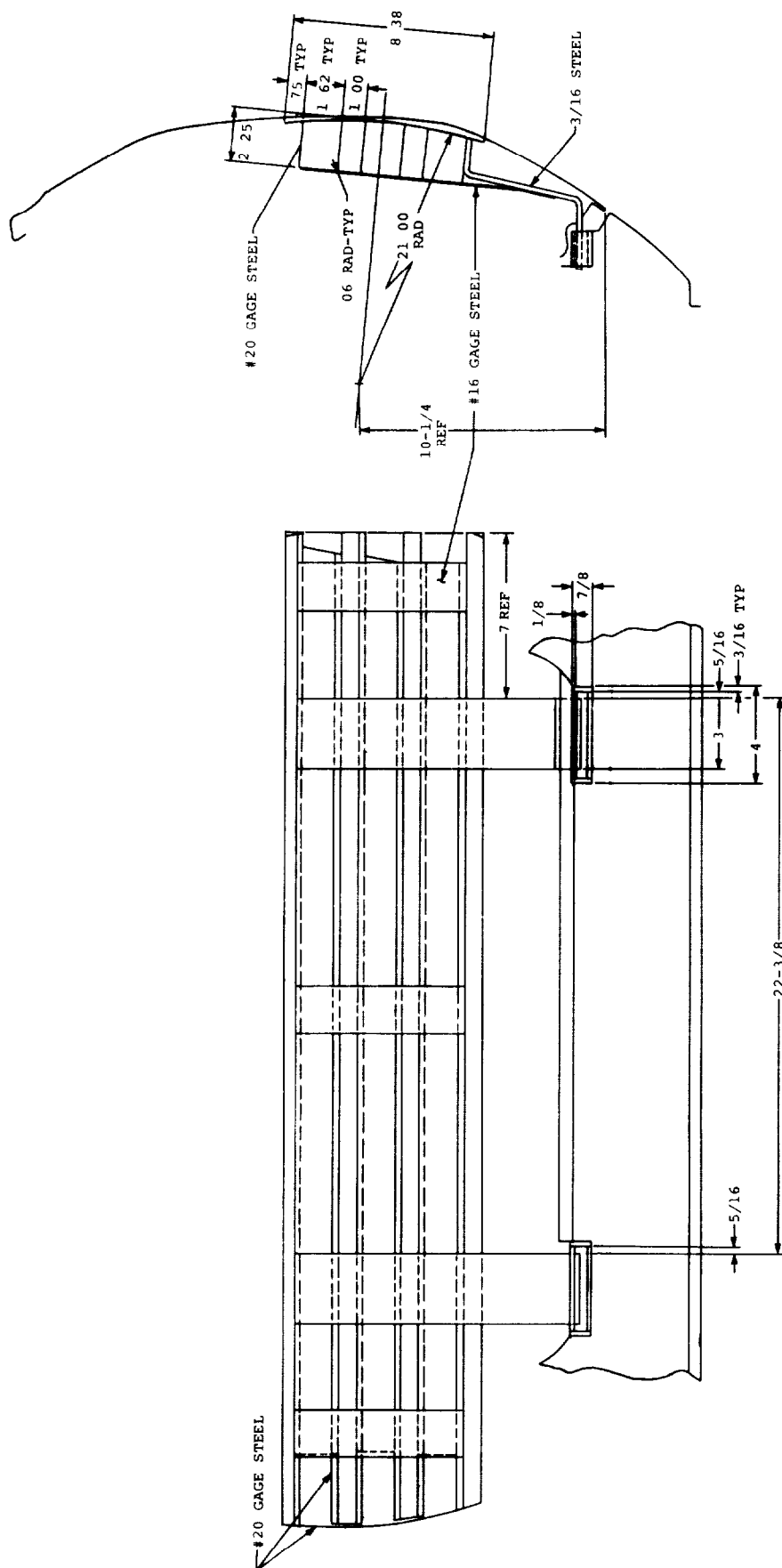


Figure 3. Drawing of Modified Door Guard Beam.

PRESENTATION OF RESULTS

This report presents all test results without analysis or discussion. Included in this document are the still photographs, the electronic data in plotted form, vehicle damage sketches and tabulated pre- and post-test dimensions, accelerometer location identification and summaries of the simulated occupancy data, including injury criteria values. High-speed motion pictures were also obtained for this test and have been submitted to the sponsor.

CRASH TEST SUMMARY

TEST NO. 5 PROJECT Task Order 3

DATE 6/17/77 TIME 11:05 a.m. TEMPERATURE 97°F

TEST CONDITION Torino Front-to-Volare Side (Right)

VEHICLE NO. 1 1975 Ford Torino

VEHICLE NO. 2 1976 Plymouth Volare (w/modified R.F. door)

	VEHICLE NO. 1	VEHICLE NO. 2
TEST WEIGHT (lb)	<u>4422</u>	<u>3998</u>
IMPACT ANGLE (deg)*	<u>0</u>	<u>60° (Right)</u>
IMPACT VELOCITY (mph)	<u>35.34</u>	<u>0</u>
MAX. CRUSH (in.)	<u>--</u>	<u>9-1/4</u>
BUMPER HEIGHT (in.)	<u>19-3/4</u>	<u>--</u>
SILL HEIGHT (in.)	<u>--</u>	<u>11-3/4</u>

OCCUPANTS	VEHICLE NO. 1	VEHICLE NO. 2
TYPE	<u>Part 572</u>	<u>Part 572</u>
LOCATION	<u>Driver (1), Passenger (3)</u>	<u>R.F. Passenger (3), R.R. Passenger (6)</u>
RESTRAINT	<u>Standard 1975 Ford Torino</u>	<u>Unrestrained</u>
	<u>Lap and Shoulder Belt</u>	

NUMBER OF DATA CHANNELS 55
 NUMBER OF HIGH SPEED CAMERAS 7

*WITH RESPECT TO TOW TRACK CENTERLINE

OBSERVATIONS (VEHICLE NO. 1)

GLAZING All intact

DOORS LF, LR, and RR opened easily; RF difficult to open.

SEAT ANCHORAGES O.K.

RESTRAINTS O.K.

OBSERVATIONS (VEHICLE NO. 2)

GLAZING WindshIELD cracked lower right corner, right side windows shattered. Rear backlight removed before test.

DOORS LF difficult to open and LR opened easily; RF and RR required tools to open.

SEAT ANCHORAGES O.K.

RESTRAINTS Not used.

GENERAL COMMENTS

Car 1: No compartment intrusion. RF tire blown and RF fender from headlights outward crushed back to tire.

Car 2: RR tire blown and inward crush localized between A and C pillars. Minor damage to front and rear fenders.

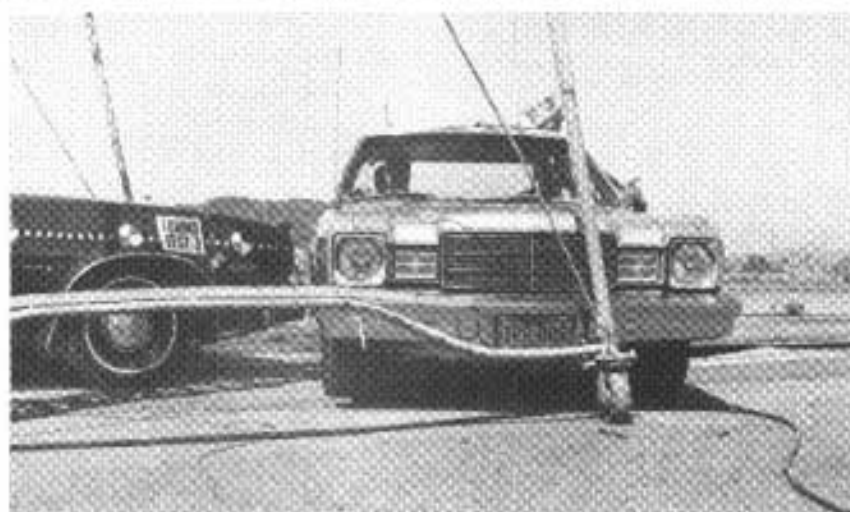


Figure 4. Pre-test No. 5 Vehicle Matching.

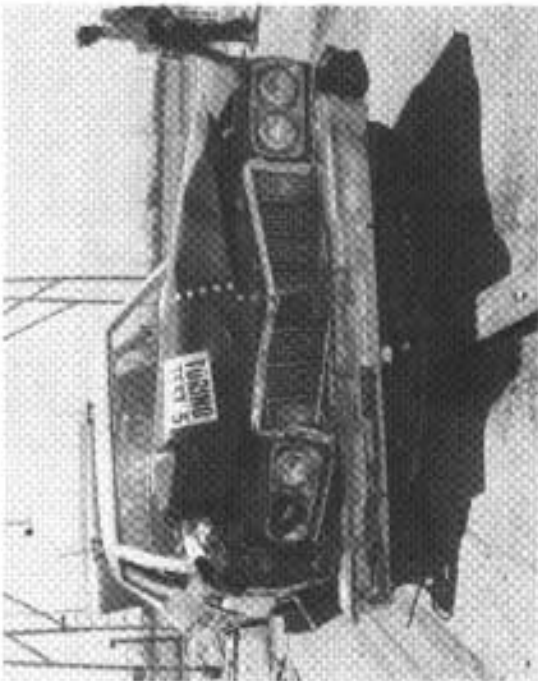


Figure 5. Post-test No. 5 Vehicles.

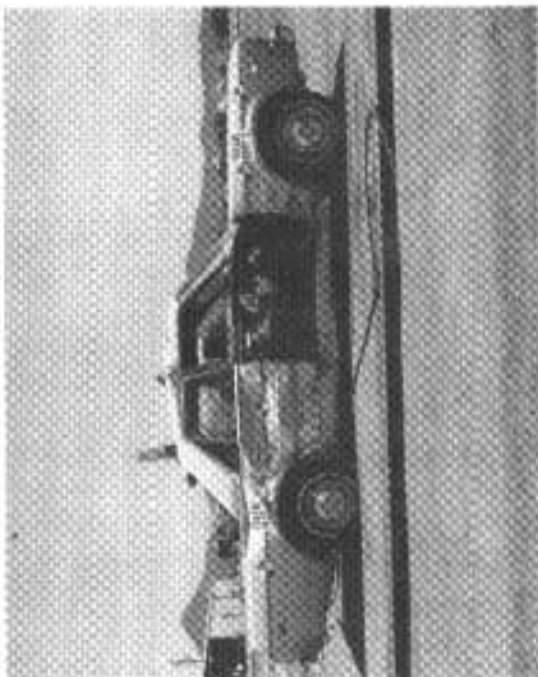


Figure 6. Post-test No. 5 1976 Plymouth Volare.

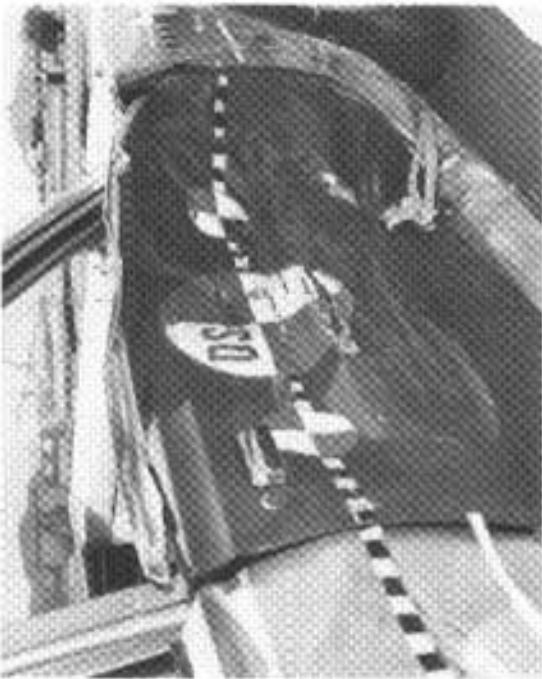


Figure 7. Post-test No. 5 1976 Plymouth Volare Right Front Door.

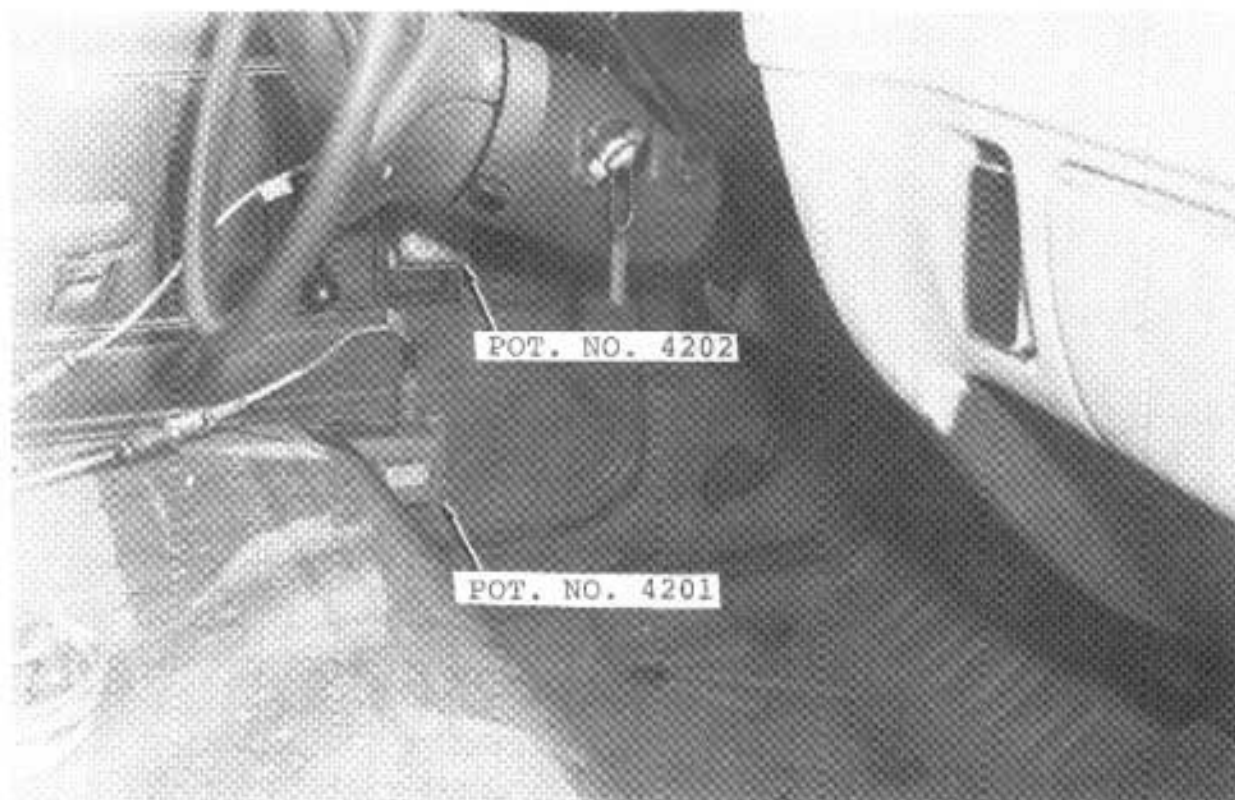


Figure 8. String Potentiometer Locations for Volare Intrusion Measurements.



Figure 9. Pre-test No. 5 1975 Ford Torino Interior.

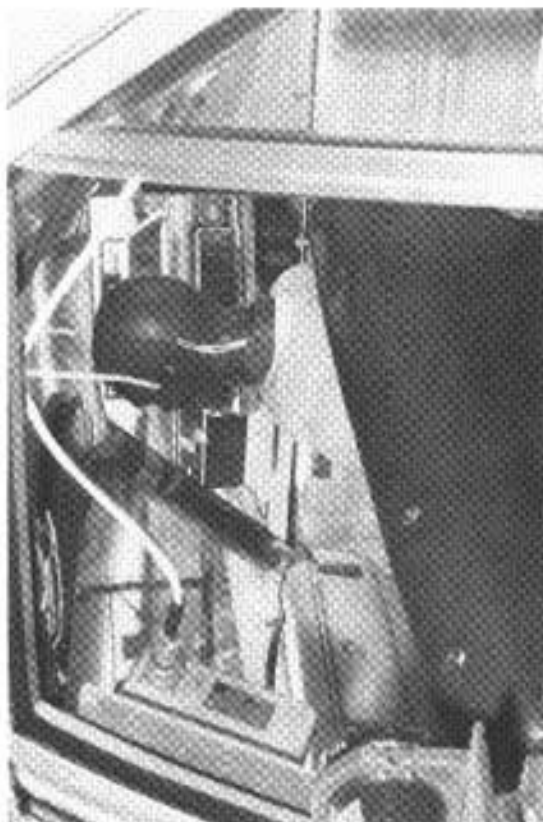
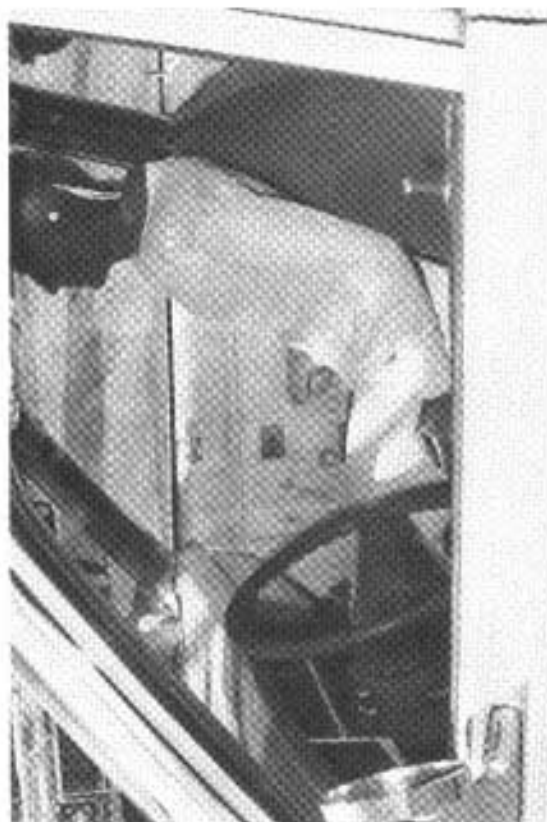
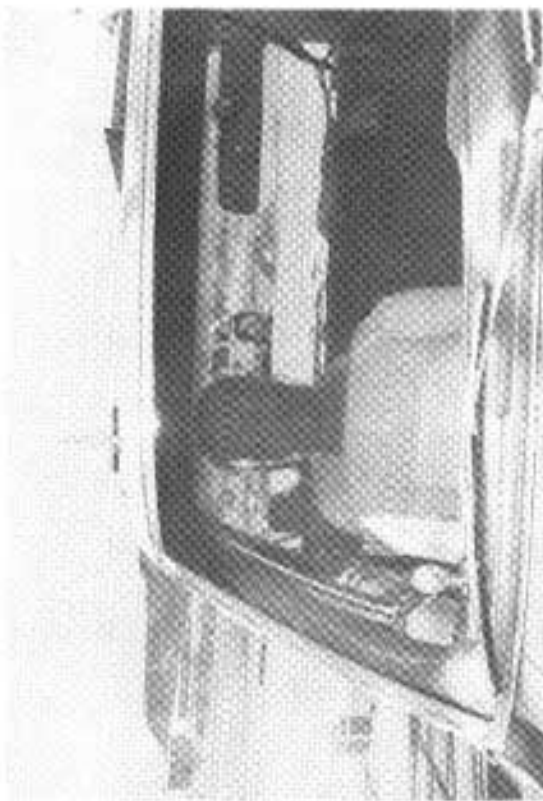


Figure 10. Pre-test No. 5 1976 Plymouth Volare Passenger Interior.



Figure 11. Post-test No. 5 1975 Torino Interior.

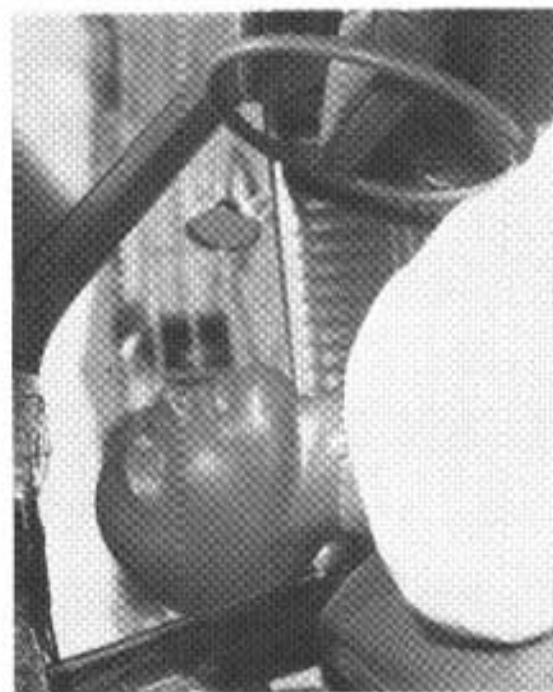
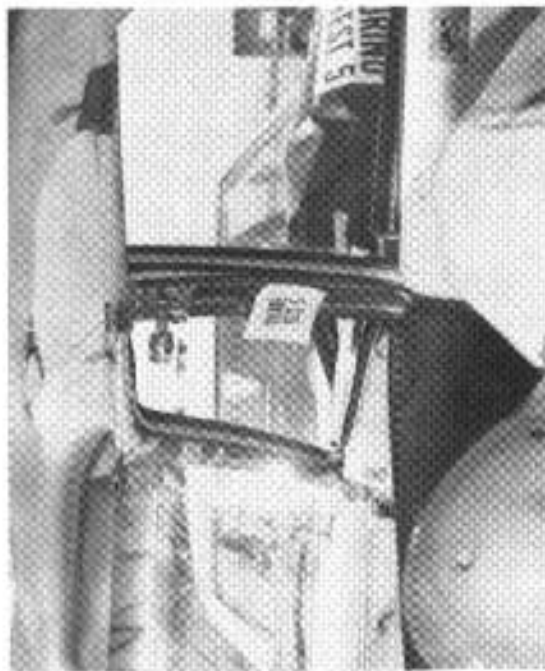
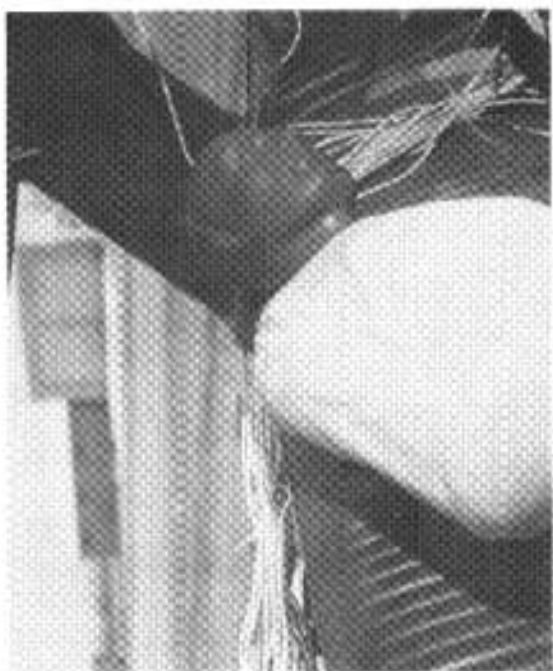


Figure 12. Post-test No. 5 1976 Plymouth Volare Interior.

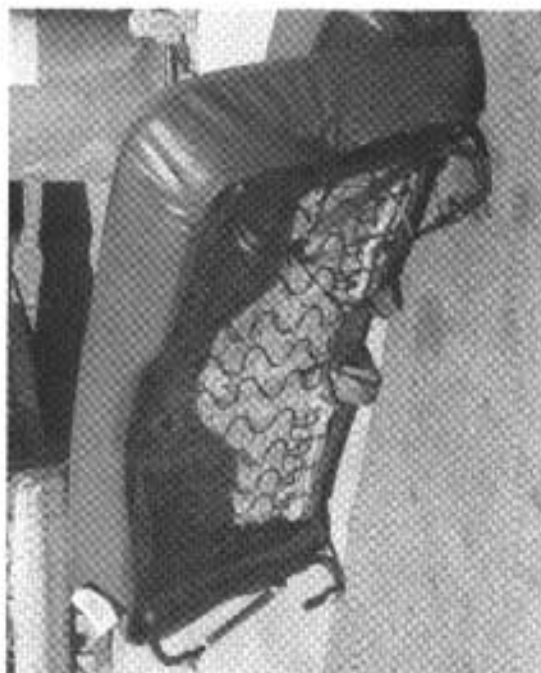


Figure 13. Interior Structural Deformation and Front Seat -
1976 Plymouth Volare.

Test No: 5 Test Date: June 17, 1977

Test Type: Side Impact

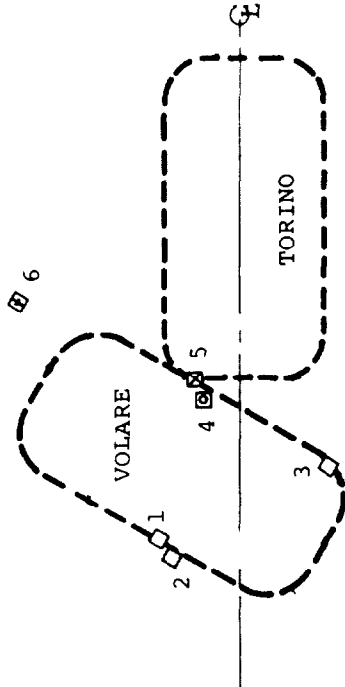
Vehicle 1

Torino

Vehicle 2

Volare

Comments:



CAMERA SYMBOLS

☐ PIT

☐ GROUND

☐ BARRIER

☒ OVERHEAD

☐ ON-BOARD

FRAME RATE

1. 1000 fr/sec

2. 200 fr/sec

3. Other 24 fr/sec

4. 400 fr/sec

5. 500 fr/sec

TIMING LIGHT SPEED

1. 100 Hz (10 msec/light)

2. 200 Hz (5 msec/light)

3. Other

CAMERA	YES
STILLS	x
SLIDES	
MOVIE	x
POLAROID	
VIDEO	
COLOR STILL	x
OF IMPACT	

Loc. No.	Location	Field of View	Lens Size	Frm Rate	Tmng Spd	Ser No	Impact Dist-X	C.L. Dist-Y	CAM Hght-Z
1	On-Board	Cut hole in roof, views dummies		1000					
2	On-Board	Look through window, views dummies		1000					
3	On-Board	Looks along interior side wall, views dummy interaction with side		1000					
4	Pit	Views under structure		1000					
5	Overhead	Views impact zone		1000					
6	Ground Based	Closeup of impact zone		1000					
7	Ground Based	Closeup of impact zone		1000					

Figure 14. Camera Locations.

10600402

MAXIMUM OCCUPANT COMPARTMENT INTRUSION WILL BE MEASURED RELATIVE TO AN UNDEFERRED VEHICLE REFERENCE LINE. EXTERIOR INTRUSION SHALL BE MEASURED, AND CONTOUR MAPS OF THE IMPACTED AND IMPACTING VEHICLES WILL BE PREPARED.

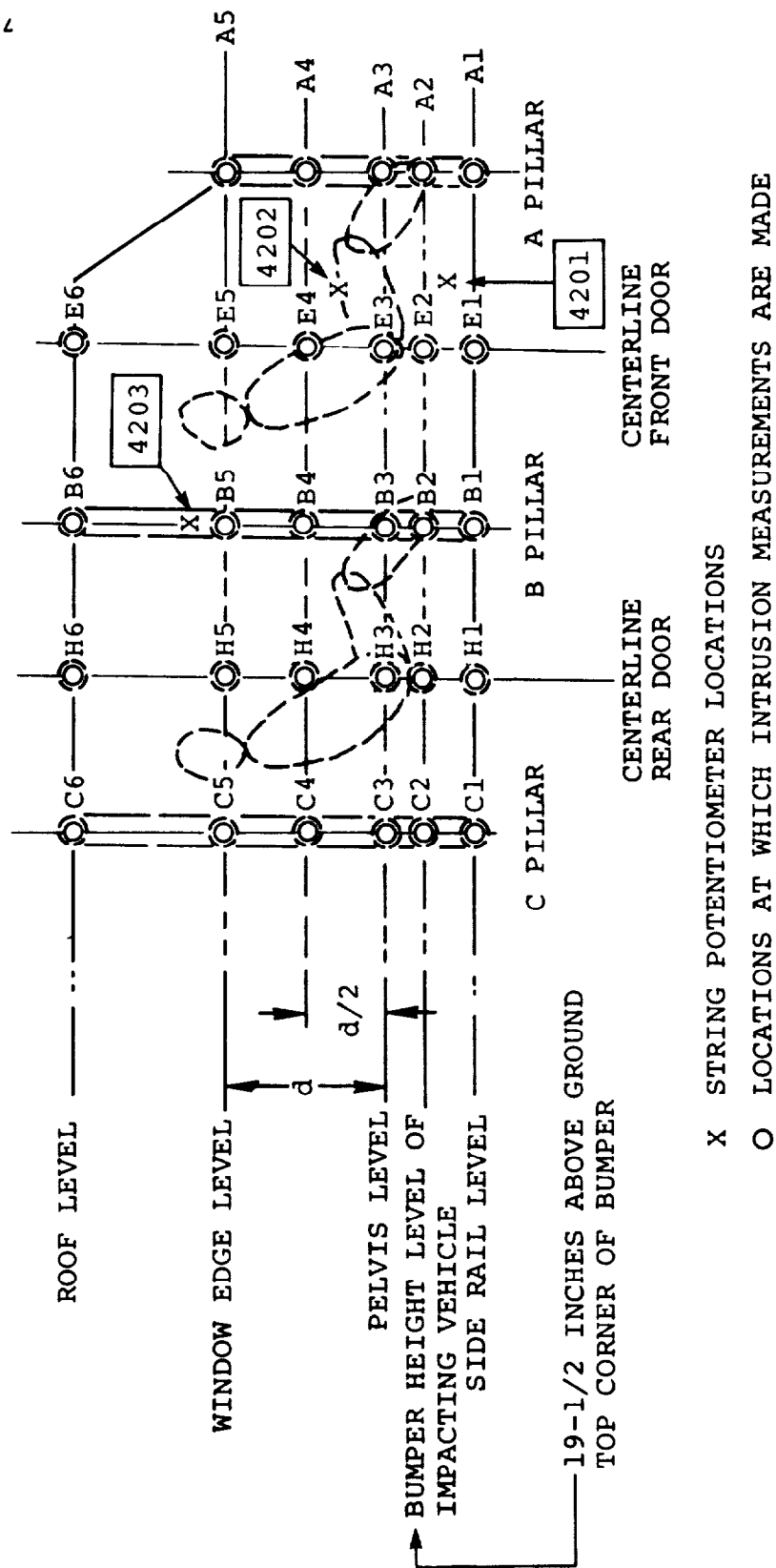


Figure 15. Intrusion Measurement Locations.

INTERIOR AND EXTERIOR DIMENSIONS, #5

VEHICLE Volare

DATE 6/17/77

D.S. NO. 524

PROJ. TEST NO. 3976 Test #5

<u>Vehicle Dimensions</u>	<u>Pre</u>	<u>Post</u>	<u>Difference</u>
H1	78-1/8	72-5/8	5-1/2
H2	78-1/8	72-3/4	5-3/8
H3	78	73-1/2	4-1/2
H4	76-1/8	73-1/8	3
H5	76-1/4	72-5/8	3-5/8
H6	70-5/8	68-5/8	2
C5	76-7/8	76-1/4	5/8
C6	72-3/8	72	3/8
B1	76-1/4	68-5/8	7-5/8
B2	76-3/8	67-3/4	8-5/8
B3	76-1/4	67	9-1/4
B4	75-3/4	66-5/8	9-1/8
B5	75-3/4	66-3/4	9
B6	70-7/8	66-1/2	4-3/8

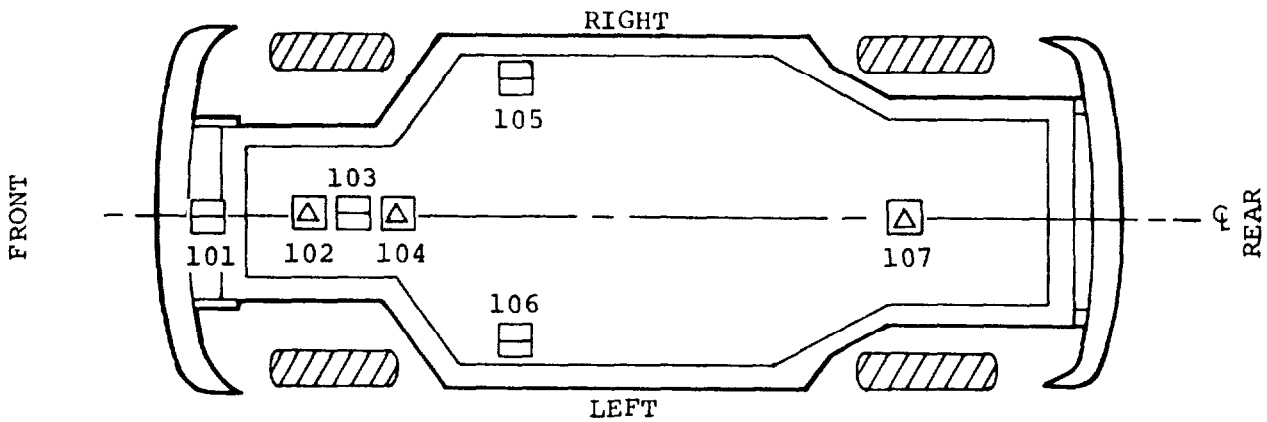
INTERIOR AND EXTERIOR DIMENSIONS, #5

VEHICLE Volare DATE 6/17/77
D.S. NO. 524 PROJ. TEST NO. 3976, Test #5

<u>Vehicle Dimensions</u>	<u>Pre</u>	<u>Post</u>	<u>Difference</u>
E1	76-7/8	71	5-7/8
E2	77	70-1/2	6-1/2
E3	77-3/8	70-1/2	6-7/8
E4	76-3/8	69-5/8	6-3/4
E5	76	69-5/8	3-3/8
E6	71-7/8	70-1/2	1-3/8
A1	61	56-1/8	4-7/8
A2	59-1/4	56-1/4	6
A3	59	56-1/4	2-3/4
A4	59-1/2	58	1-1/2
A5	59-1/8	58-1/4	7/8

TEST NO: 5 VEHICLE: TORINO DS NO: 419

70400903



LINEAR
ACCELEROMETERS

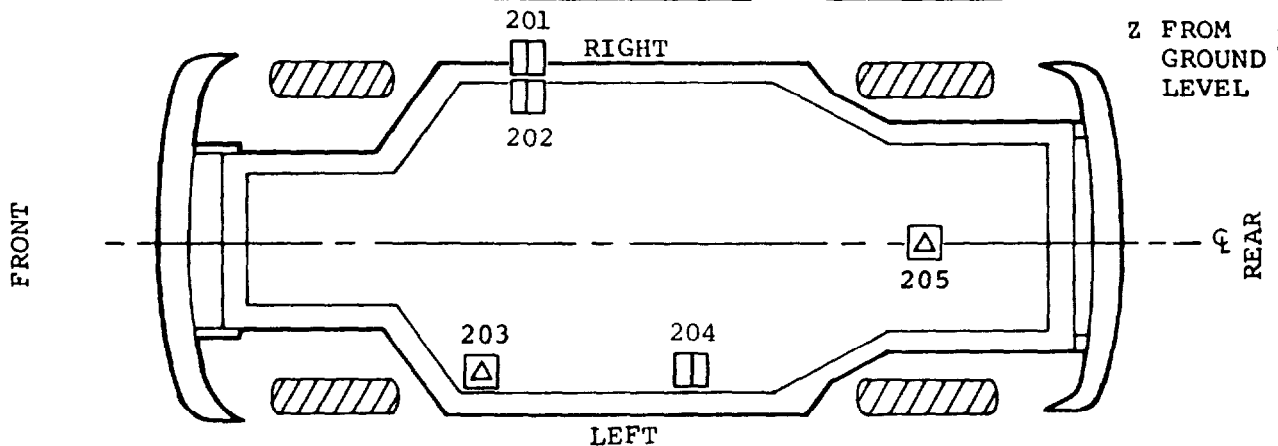
- ☐ LONGITUDINAL
- ☐ LATERAL
- ☒ VERTICAL
- ☐ TRIAXIAL

VEHICLE TRANSDUCER LOCATIONS

NO.	DESCRIPTION OF LOCATION	X	Y	Z
101	Behind Front Bumper	X	-	-
102	Engine	X	X	X
103	Front Suspension Right Side (Unsprung Mass)	X	-	-
104	Firewall on Vehicle C	X	X	X
105	Rocker Panel Inside Car	X	-	-
106	Rocker Panel Inside Car	X	-	-
107	Vehicle Center Line, Trunk Floor Right Behind Rear Seat	X	X	X

Figure 16. Torino Instrumentation.

TEST NO: 5 VEHICLE: VOLARE DS NO: 524



VEHICLE TRANSDUCER LOCATIONS

LINEAR
ACCELEROMETERS

- ☐ LONGITUDINAL
- ☐ LATERAL
- ☐ VERTICAL
- ☐ TRIAXIAL

NO.	DESCRIPTION OF LOCATION	X	Y	Z
Accelerometers				
201	Center of Door (inside) at H-Point Height		X	
202	Directly Below No. 1 Mounted on Rocker Panel (inside)		X	
203	Inside on Rocker Panel Front Door Area	X	X	X
204	Inside on Rocker Panel Rear Door Area		X	
205	Trunk Floor on Vehicle Center Line Directly Behind Rear Seat	X	X	
Displacement (String Potentiometers) (See Note)				
4201	Across Front Doors 3 Inches Above Floor on Door Center Line			
4202	Above No. 1 at Window Ledge			
4203	Across Front Seat Back Between "B" Pillars			

NOTE: If the dummy or any part of the vehicle contacts the string during impact, the net effect will be to reduce the amount of string retracted which could be interpreted erroneously as less than actual lateral displacement. High-speed films should be viewed to determine whether dummy interference has occurred.

Figure 17. Volare Instrumentation.

INSTRUMENTATION SUMMARY

TEST NO: 5

VEHICLE: Volare

Instrument	Number	Total No. of Channels
Vehicle Accelerometers	5 Locations	8
Dummies - Head(3), Chest(3), Pelvis(2)	2 Locations	16
Load Cells		
Strain Gauges		
String Potentiometers	3 Locations	3
1) Across front floor above tunnel 3" in front of seat		
2) Inside across window ledges directly above string pot #1		
3) Inside above front seat back across the 'B' pillars		

TOTAL 27

VEHICLE: Torino

Instrument	Number	Total No. of Channels
Vehicle Accelerometers	7 Locations	12
Dummies - Head (3), Chest(3), Femurs(2)	2 Locations	16
Load Cells		
Strain Gauges		
String Potentiometers		

TOTAL 28

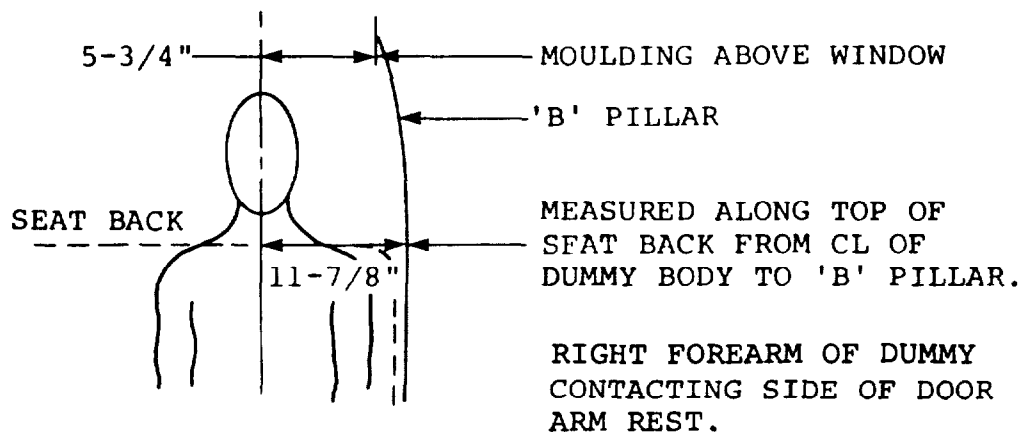
Barrier Load Cells: Yes ☐

 No ☒

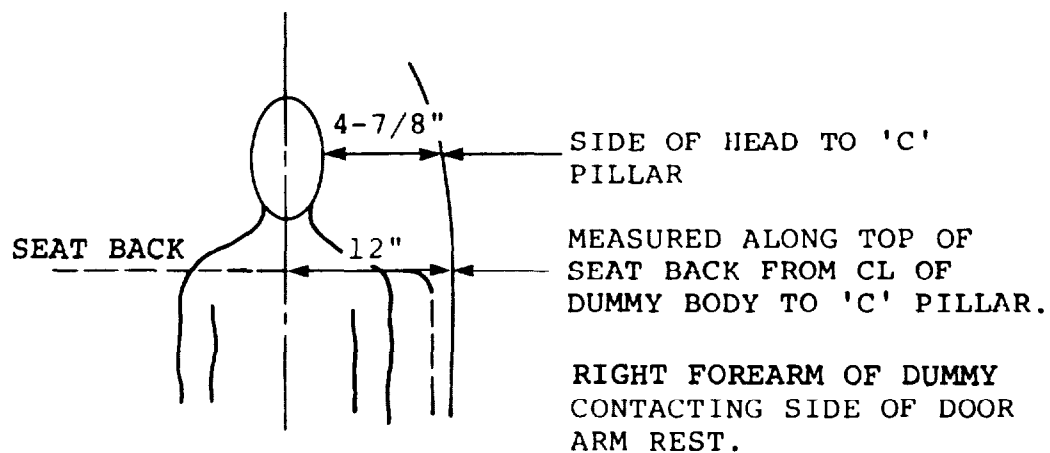
Full Scale: Top Row _____

 Bottom Row _____

VEHICLE Volare TEST DATE 6/17/77
TEST NUMBER 5



RIGHT FRONT DUMMY



RIGHT REAR DUMMY

Volare Dummy Pre-test No. 5 Positions Relative to Side of the Car.

DUMMY INJURY CRITERIA VALUES
CAR 1 - 1975 Ford Torino

	Maximum Acceleration ("G")											
	Head				Chest				Pelvis			
	X	Y	Z	R	X	Y	Z	R	X	Y	Z	R
Dummy (1)	19	18	17	28	16	5	5	17				
Dummy (3)	18	11	16	19	13	2	4	13				
Dummy												
Dummy												

	Maximum Force - Femur Load (lb)	
	Right Femur	Left Femur
Dummy (1)	379	232
Dummy (3)	129	125
Dummy		
Dummy		

	Maximum Force - Seat Belts Loads (lb)		
	Shoulder Strap Upper Belt Load	Lap Strap Right Belt Load	Lap Strap Left Belt Load
Dummy (1)	--	--	--
Dummy (3)	--	--	--
Dummy			
Dummy			

	Head Injury Criteria*				Severity Index	
	HIC	t ₁ (sec)	t ₂ (sec)	Ave. Acc. (G) t ₁ to t ₂	Head	Chest
Dummy (1)	58	.086	.196	12	92	33
Dummy (3)	59	.117	.200	14	78	23
Dummy						
Dummy						

*As defined in FMVSS No. 208.

DUMMY INJURY CRITERIA VALUES
CAR 2 - 1976 Plymouth Volare

	Maximum Acceleration ("G")											
	Head				Chest				Pelvis			
	X	Y	Z	R	X	Y	Z	R	X	Y	Z	R
Dummy (3)	97	36	48	114	6	58	11	59	14	66	--	67
Dummy (6)	27	84	28	87	8	24	8	25	12	37	--	37
Dummy												
Dummy												

	Maximum Force - Femur Load (lb)	
	Right Femur	Left Femur
Dummy (3)	--	--
Dummy (6)	--	--
Dummy		
Dummy		

	Maximum Force - Seat Belts Loads (lb)		
	Shoulder Strap Upper Belt Load	Lap Strap Right Belt Load	Lap Strap Left Belt Load
Dummy (3)	--	--	--
Dummy (6)	--	--	--
Dummy			
Dummy			

	Head Injury Criteria*				Severity Index	
	HIC	t ₁ (sec)	t ₂ (sec)	Ave. Acc. (G) t ₁ to t ₂	Head	Chest
Dummy (3)	123	.111	.114	71	280	177
Dummy (6)	177	.073	.079	61	222	73
Dummy						
Dummy						

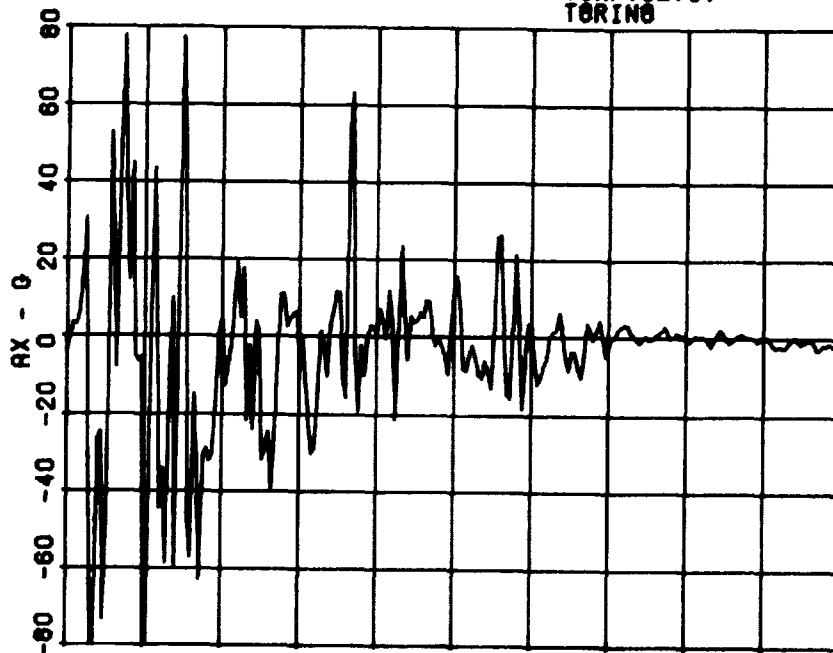
*As defined in FMVSS No. 208.

TASK 3, TEST 5

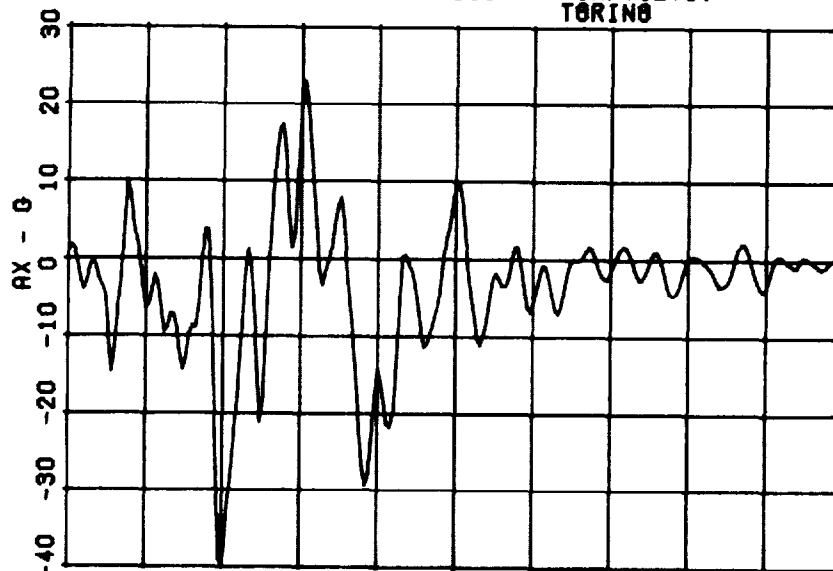
CAR 1 - 1975 TORINO VEHICLE DATA

NOTE: All data is filtered at 100
Hz (Class 60, SAE J211).
See Figure 16 for location
of transducers.

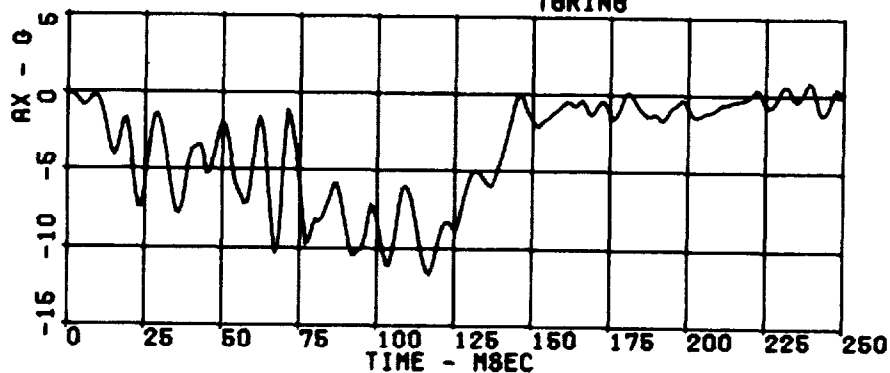
DATE 06-17-77 FILTER 315 LOCATION 101 TEST NO 082577
 TOR/VOL(5)
 TORING



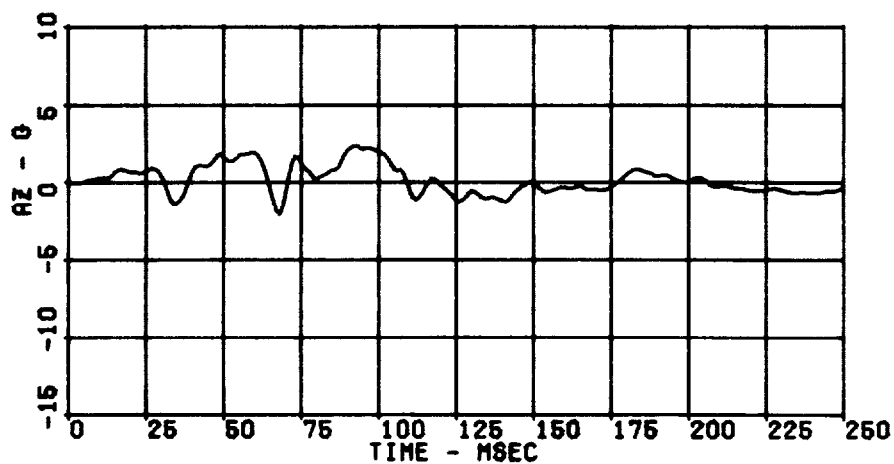
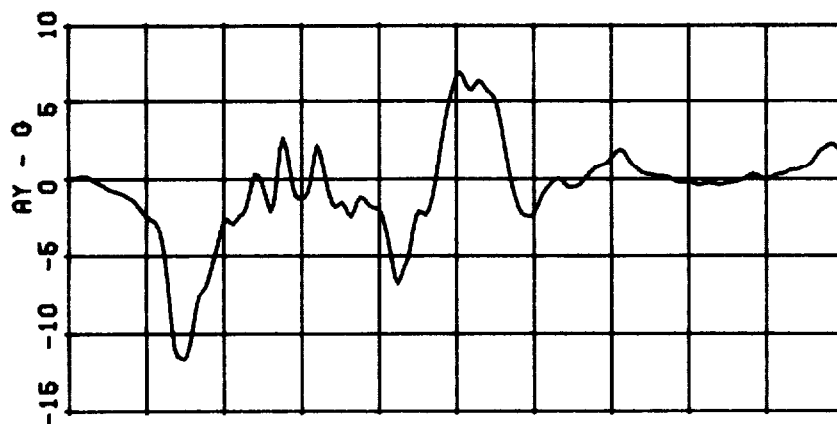
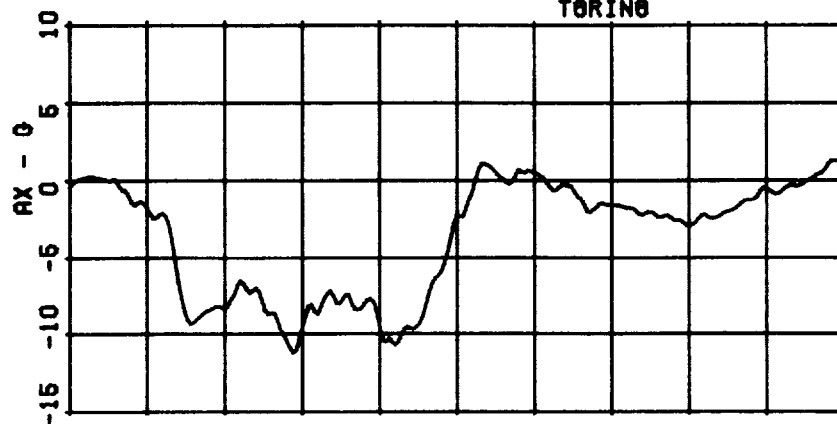
DATE 06-17-77 FILTER 315/100 LOCATION 103 TEST NO 081777
 TOR/VOL(5)
 TORING



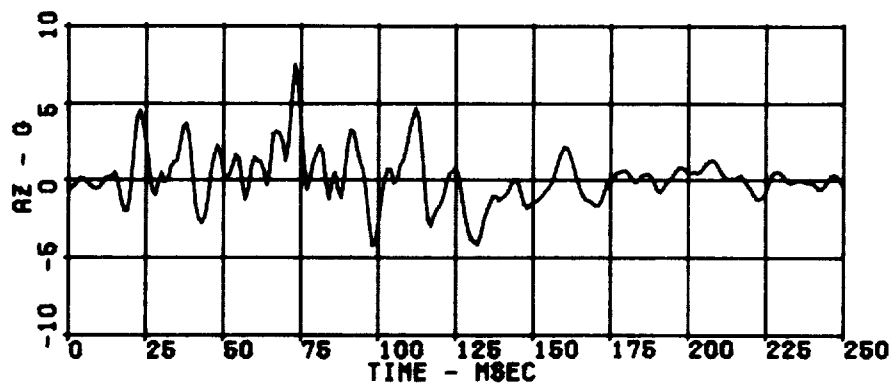
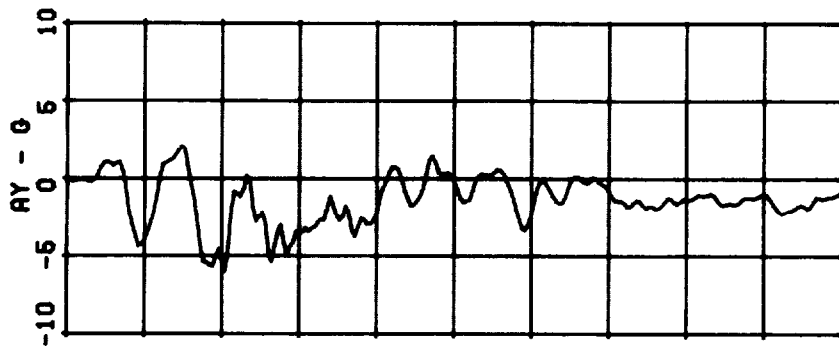
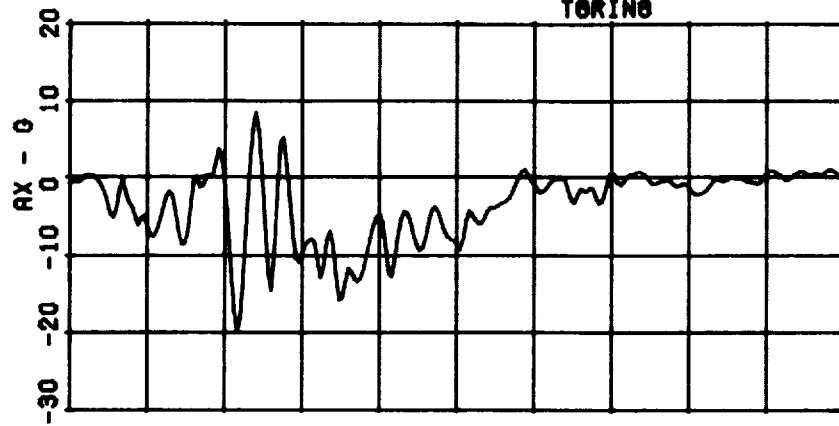
DATE 06-17-77 FILTER 315/100 LOCATION 105 TEST NO 081777
 TOR/VOL(5)
 TORING

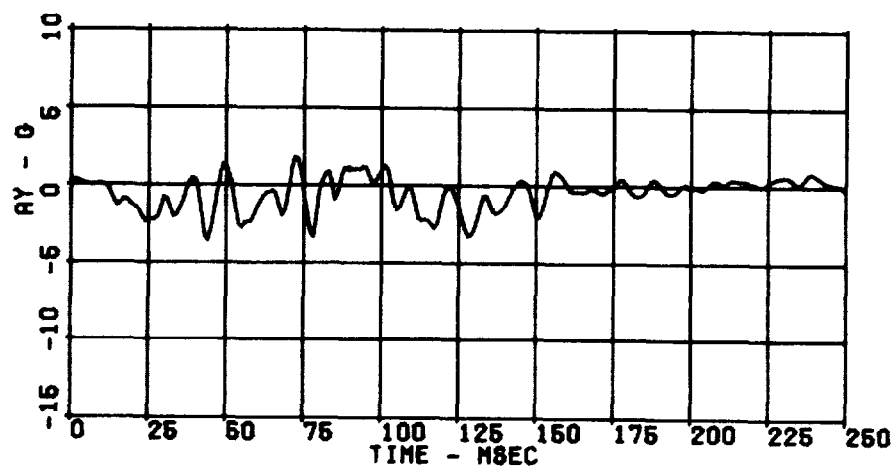
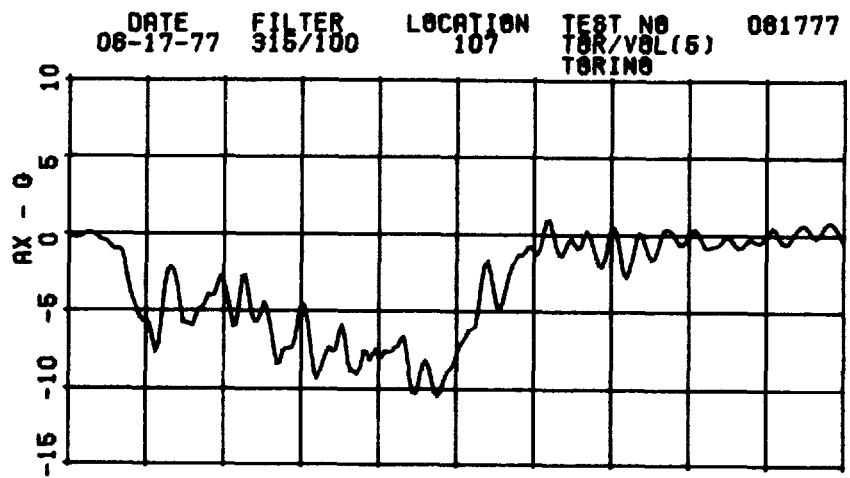
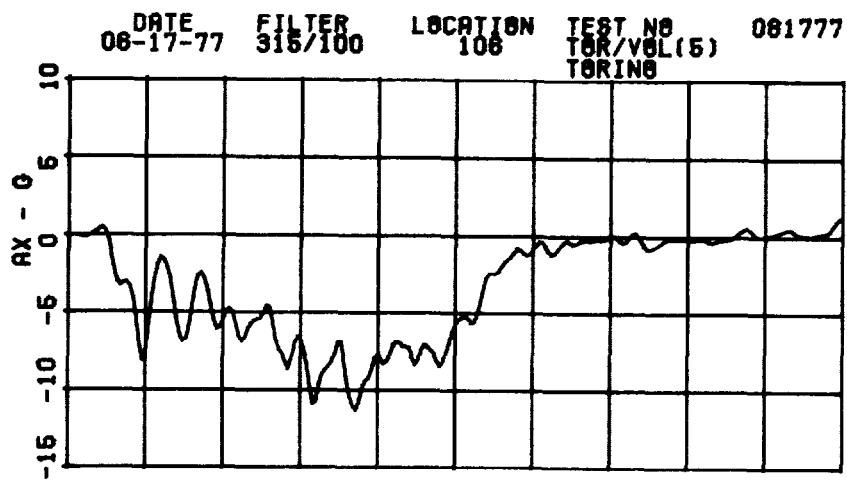


DATE 06-17-77 FILTER 316/100 LOCATION 102 TEST NO 081777
 TOR/VOL(5) TORINO



DATE 06-17-77 FILTER 316/100 LOCATION 104 TEST NO 081777
TOR/VOL(5) TORING

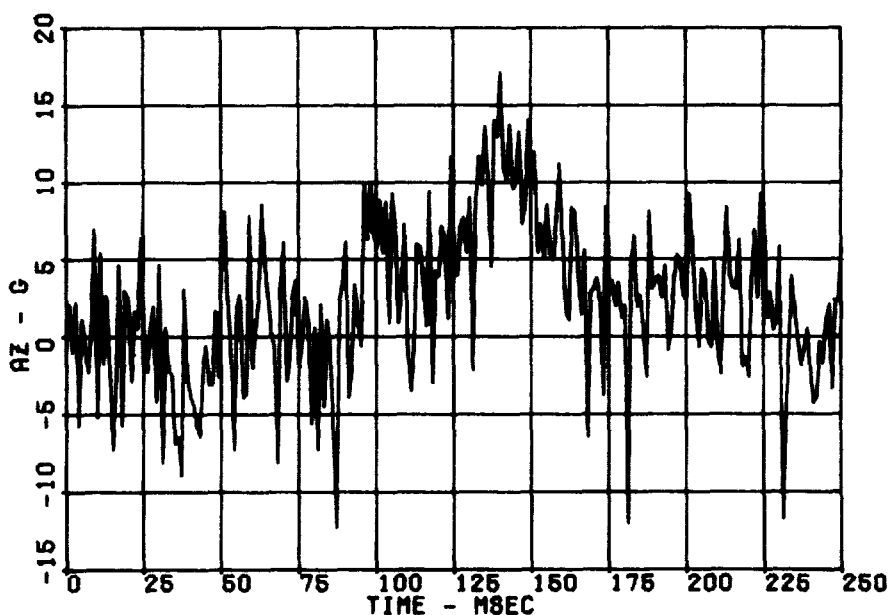
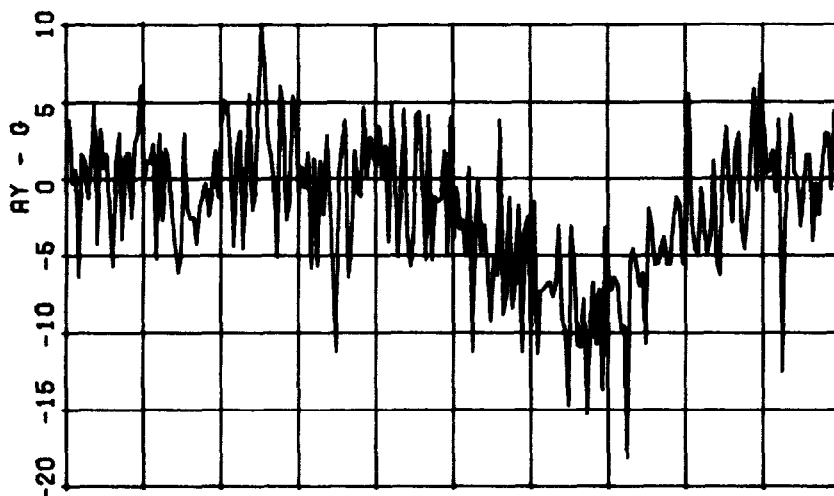
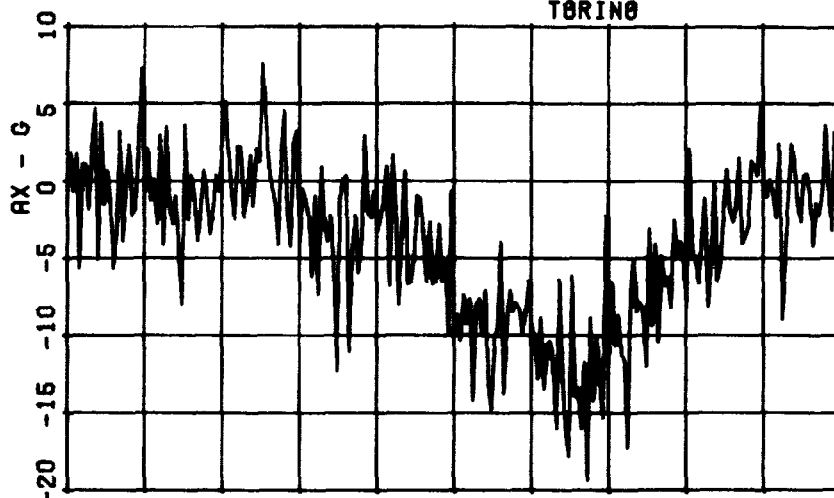


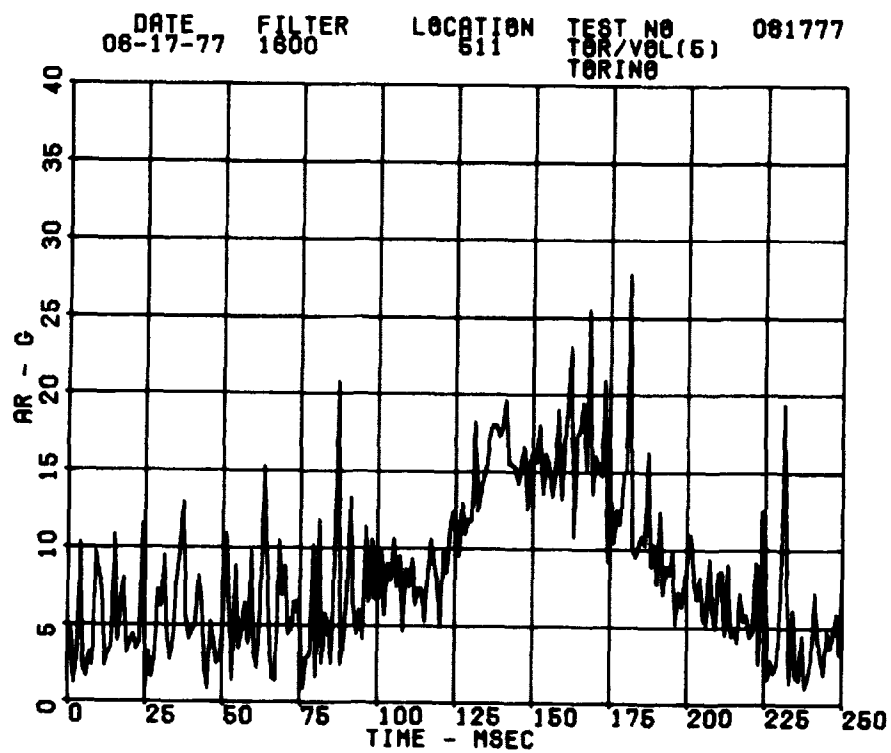


TASK 3, TEST 5
1975 TORINO DUMMY DATA

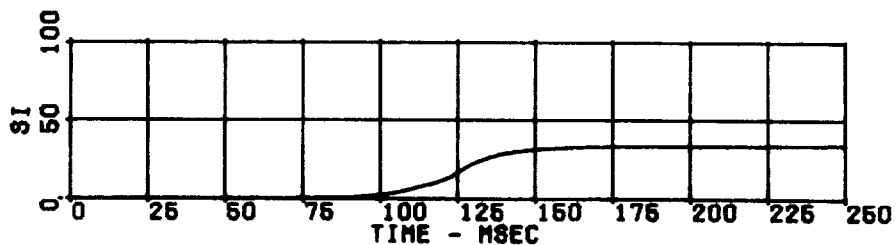
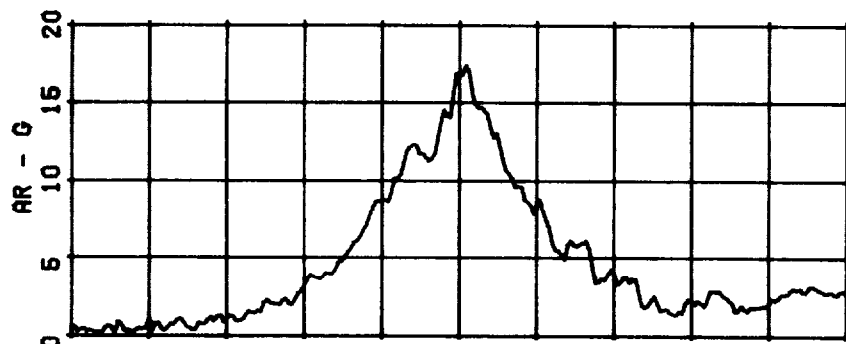
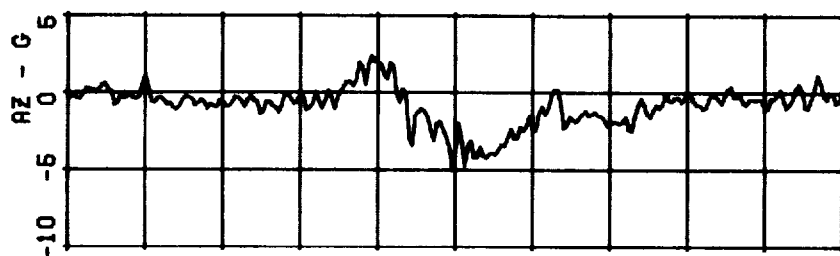
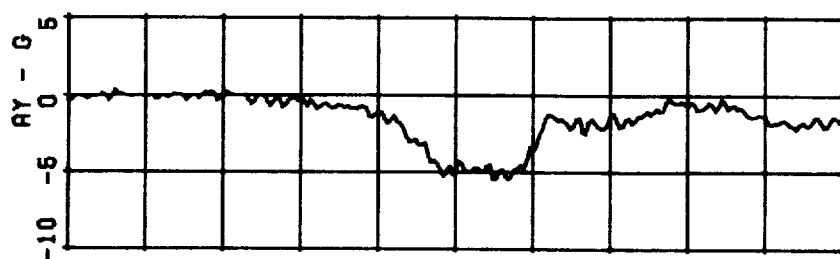
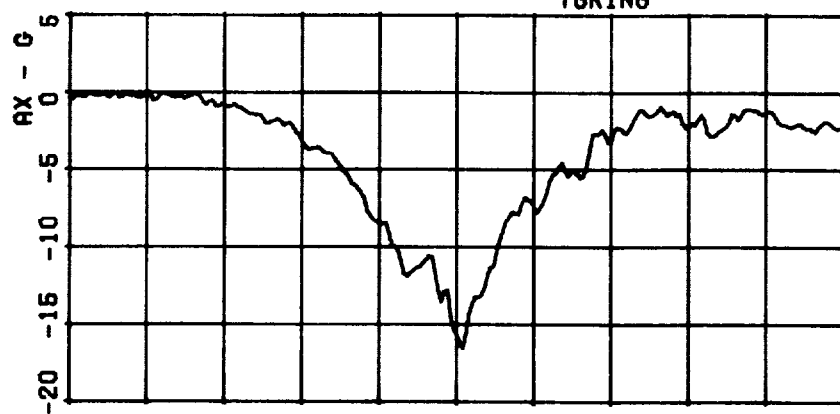
	FILTER CHANNEL CLASS	LOCATION IDENTIFICATION	
		<u>Left Front</u>	<u>Right Front</u>
HEAD ACCELERATION	1000	511	513
CHEST ACCELERATION	180	1101	1103
FEMUR FORCE	600	2111 2113	2131 2133

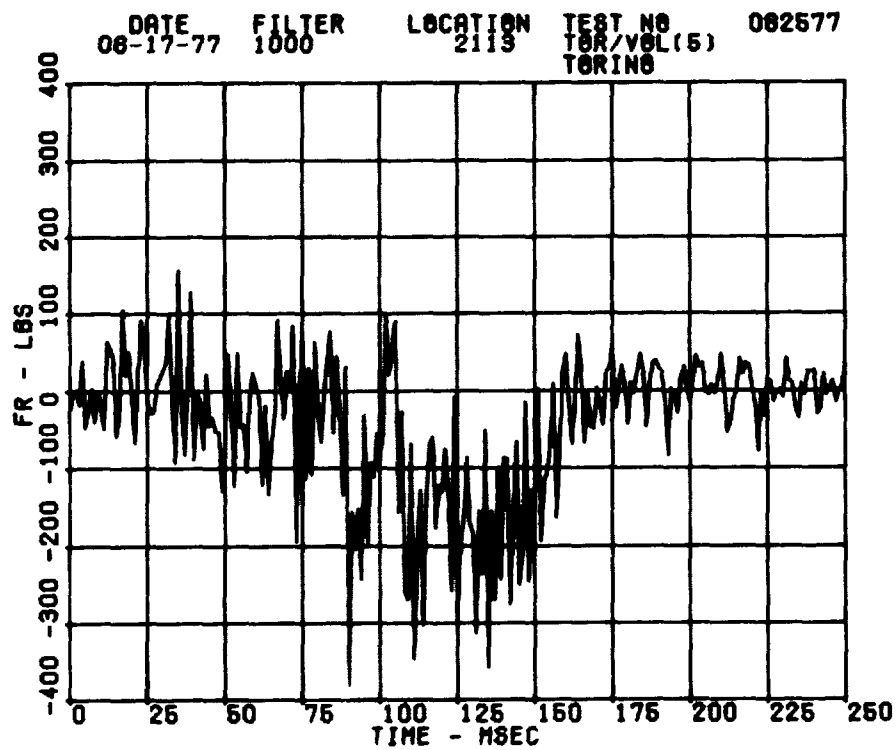
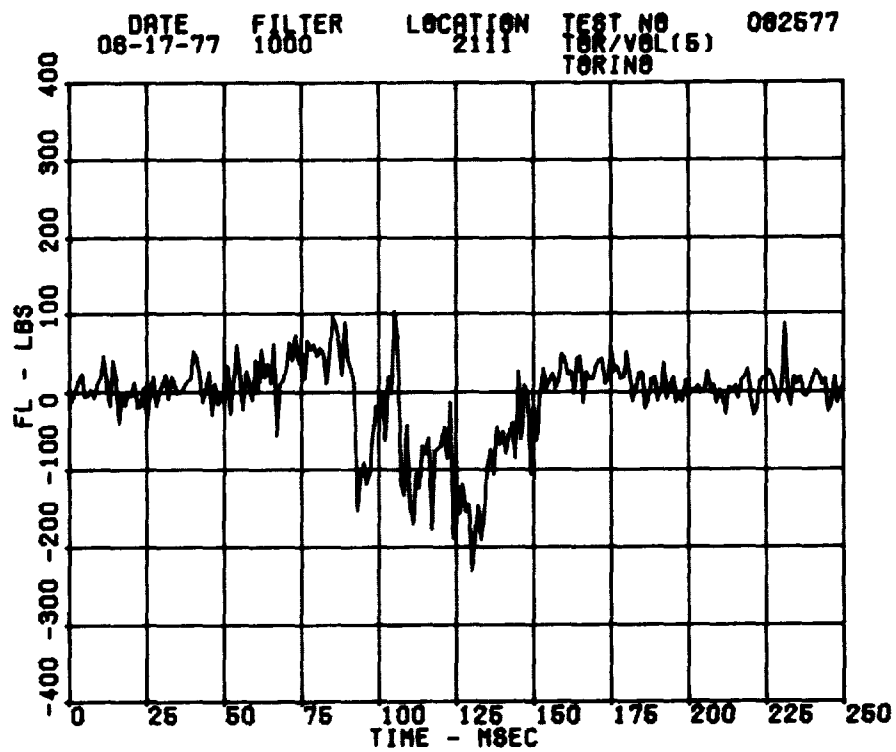
DATE 08-17-77 FILTER 1600 LOCATION 511 TEST NO 081777
 TOR/VOL(6) TORINO



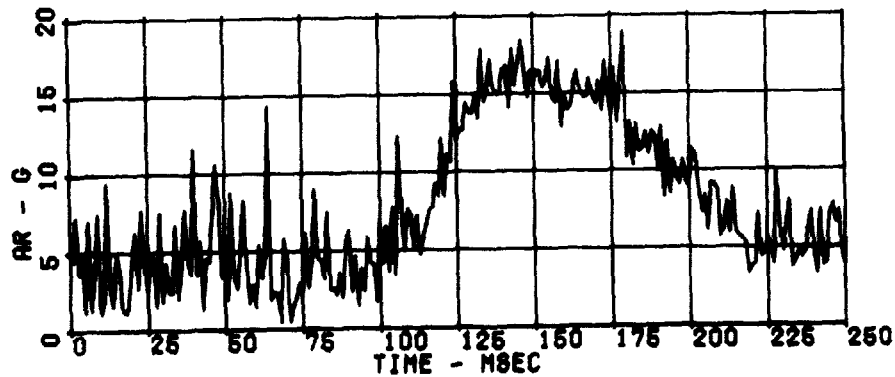
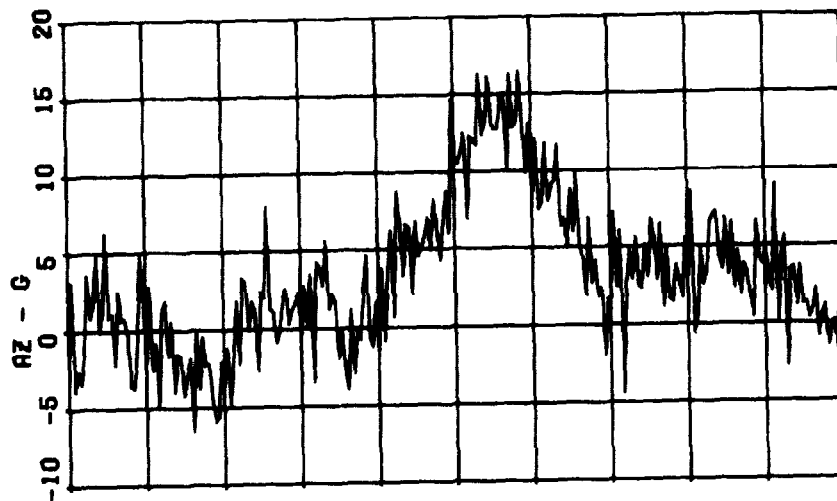
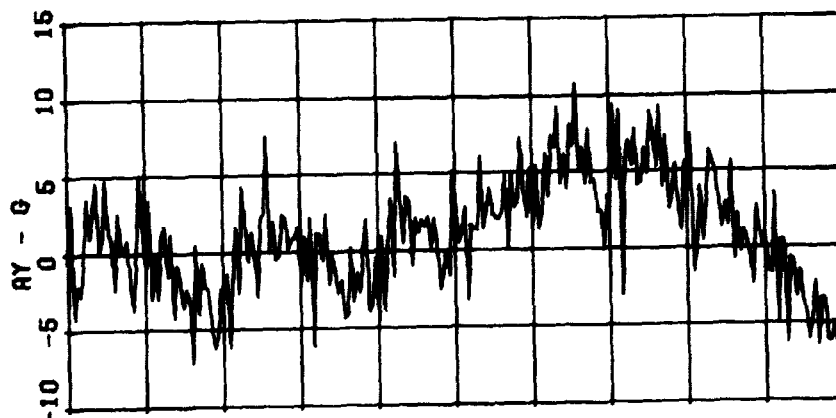
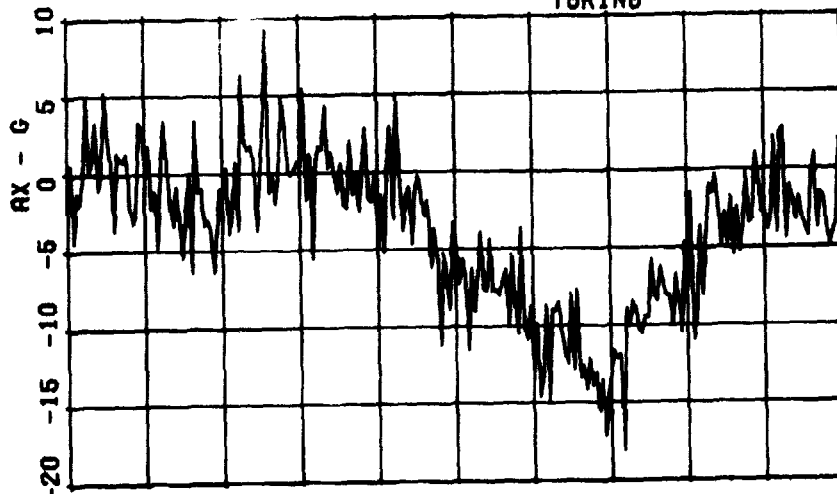


DATE 08-17-77 FILTER 316 LOCATION 1101 TEST NO 081777
 TOR/VOL(5) TORING

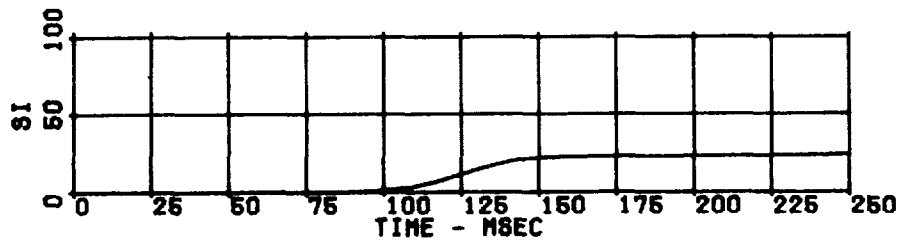
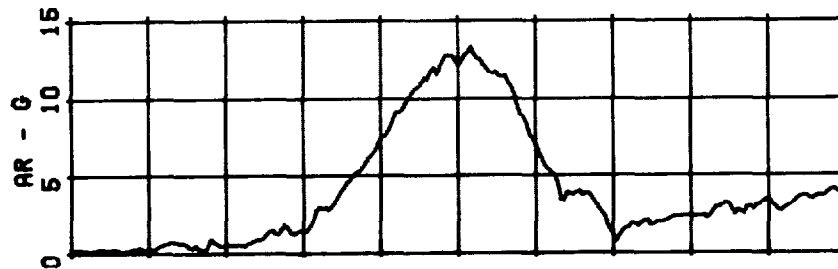
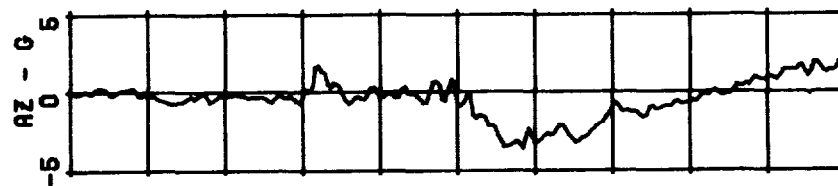
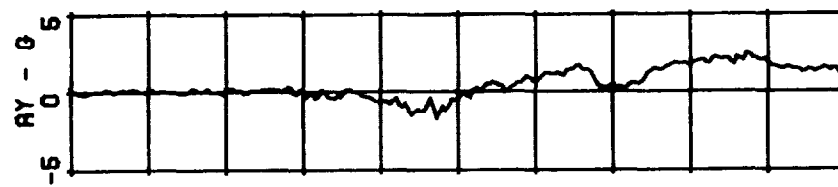
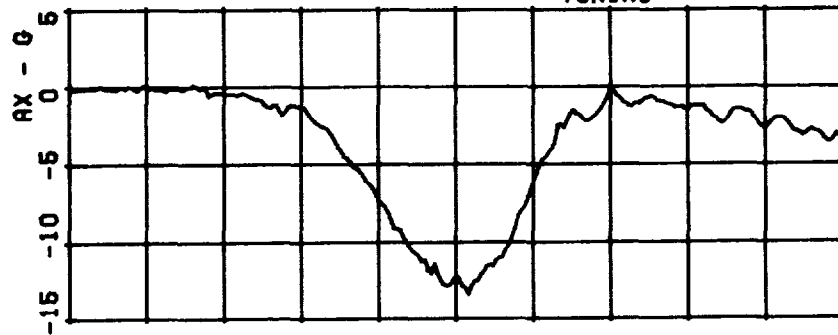


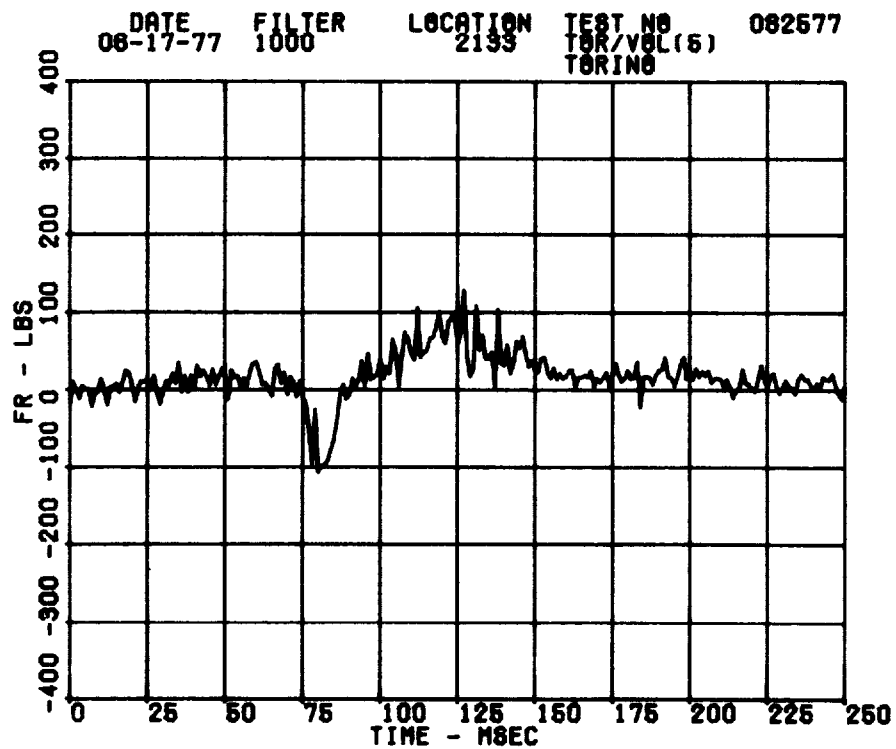
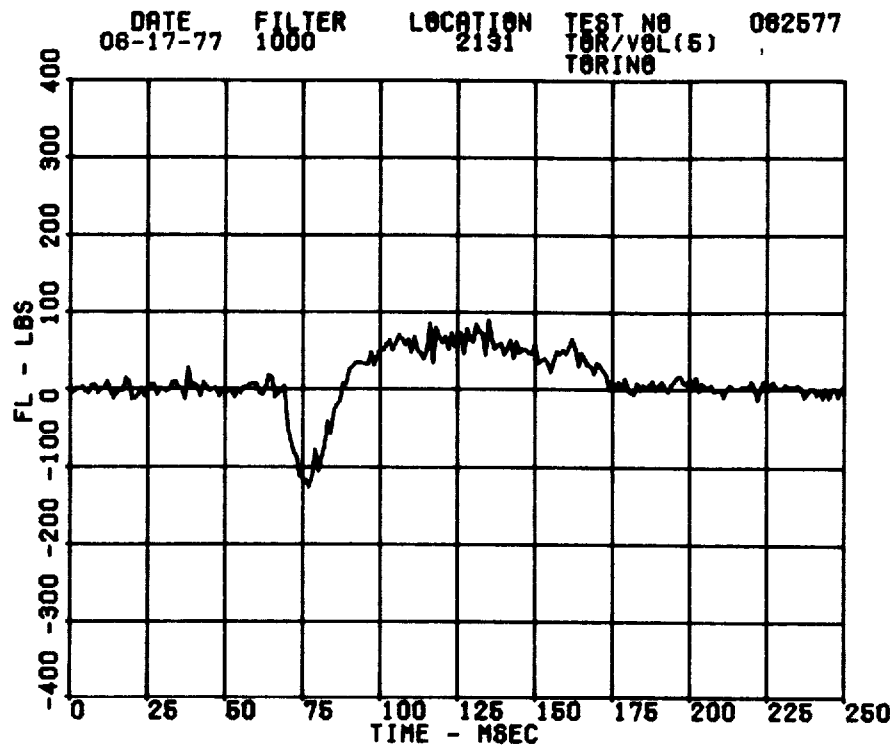


DATE 06-17-77 FILTER 1600 LOCATION 819 TEST NO 081777
 TOR/VOL(5) TORINO



DATE 08-17-77 FILTER 915 LOCATION 1103 TEST NO 081777
 TOR/VOL(5) TORING



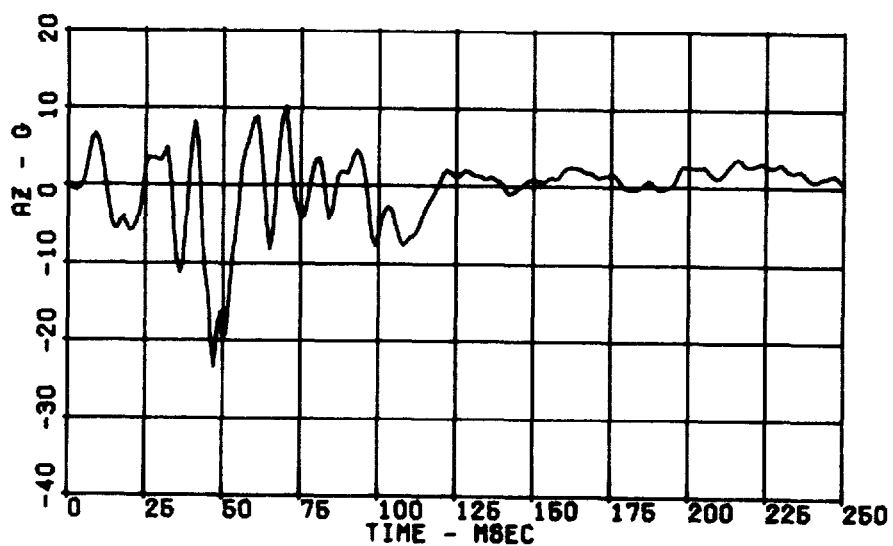
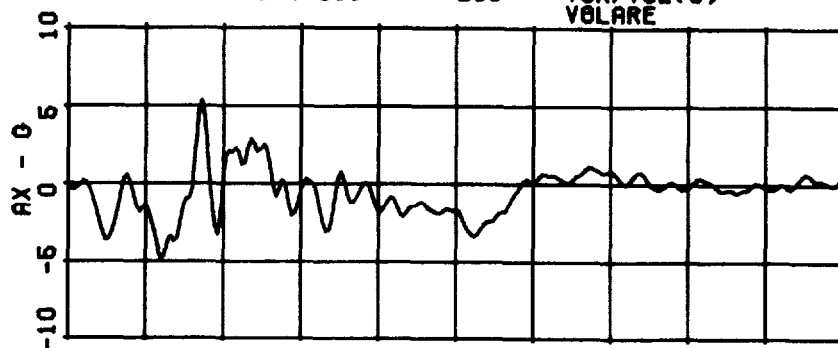


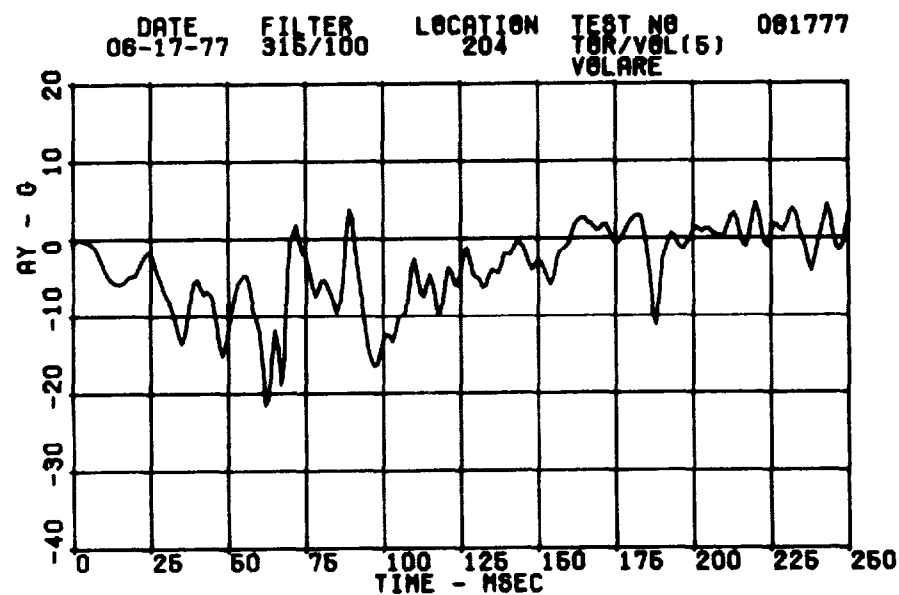
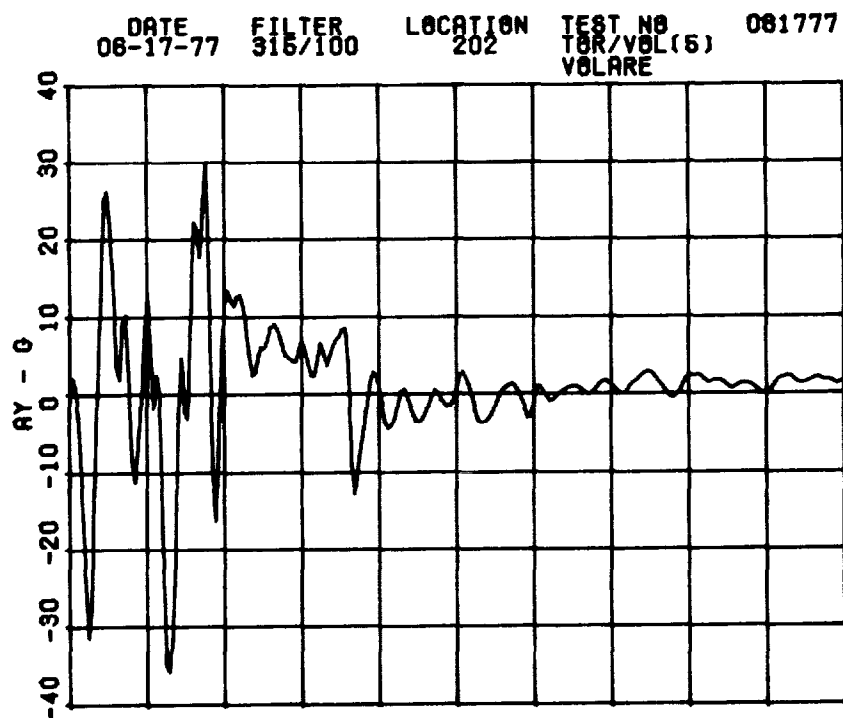
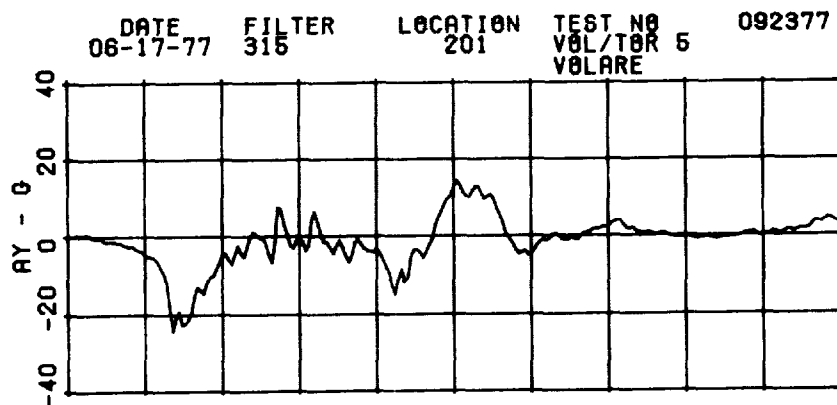
TASK 3, TEST 5

CAR 2 - 1976 VOLARE VEHICLE DATA

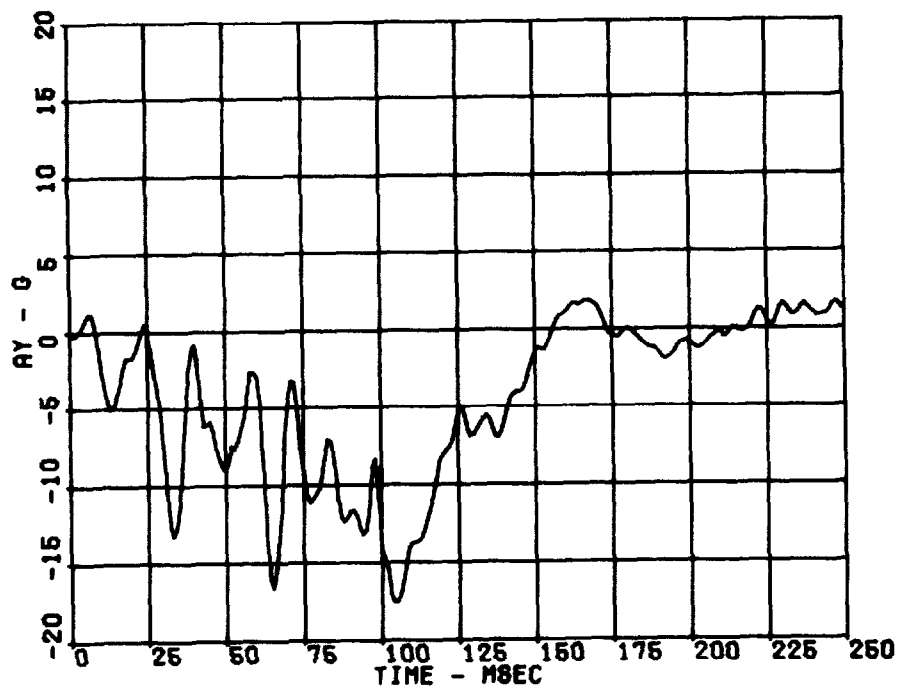
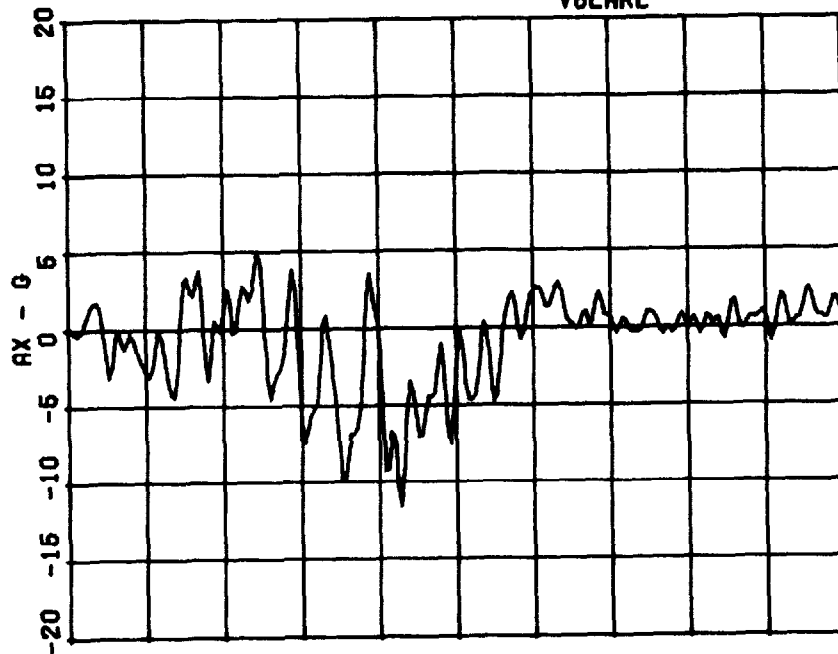
NOTE: All data is filtered at 100
Hz (Class 60, SAE J211).
See Figure 17 for location
of transducers.

DATE 06-17-77 FILTER 916/100 LOCATION 203 TEST NO 081777
 TOR/VOL(5)
 VOLARE

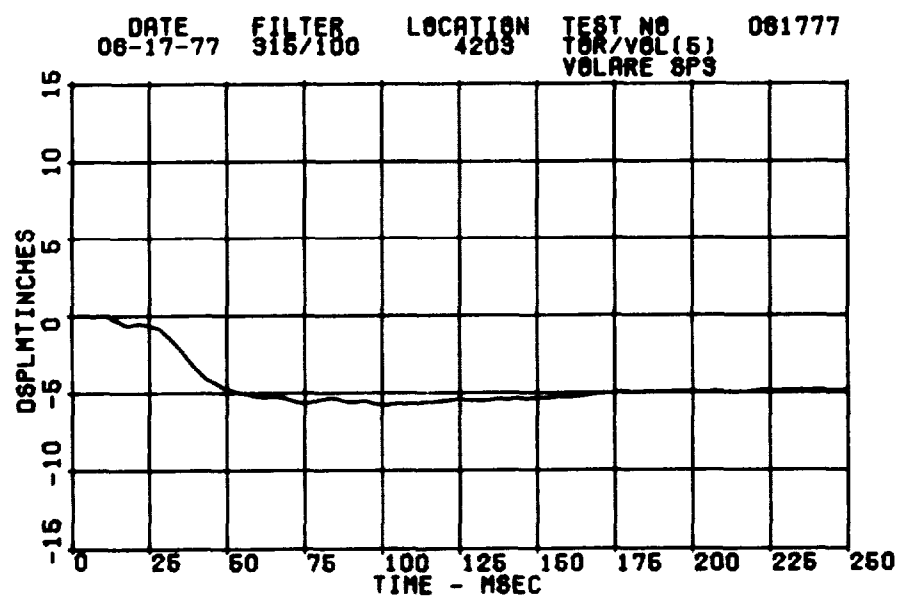
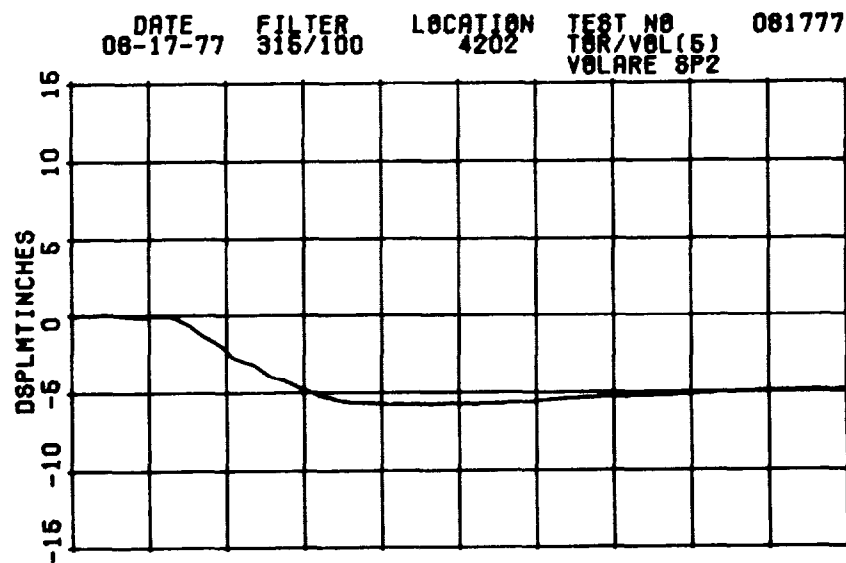
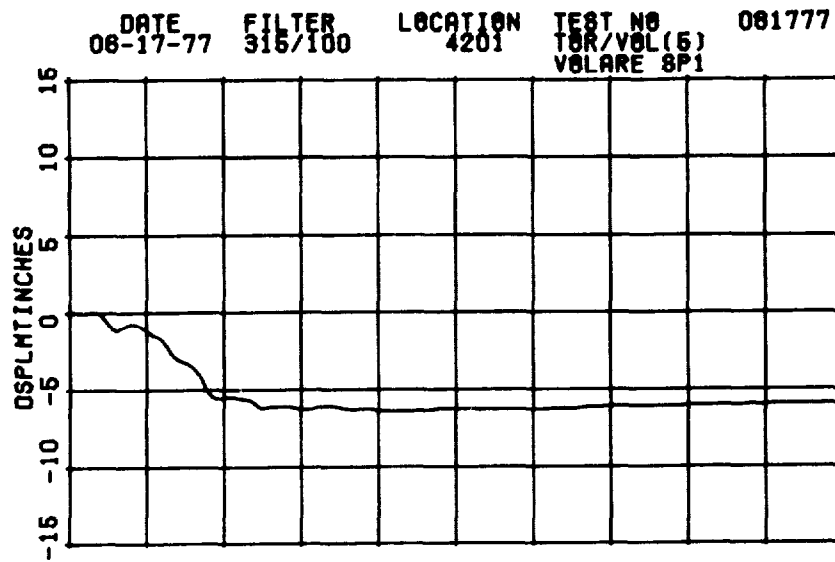




DATE 08-17-77 FILTER 315/100 LOCATION 206 TEST NO 081777
TOR/VOL(5)
VOLARE



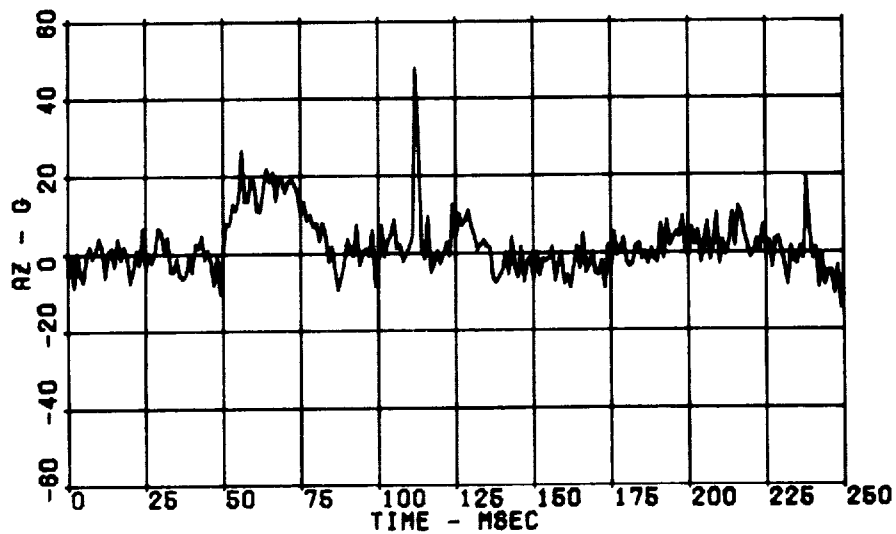
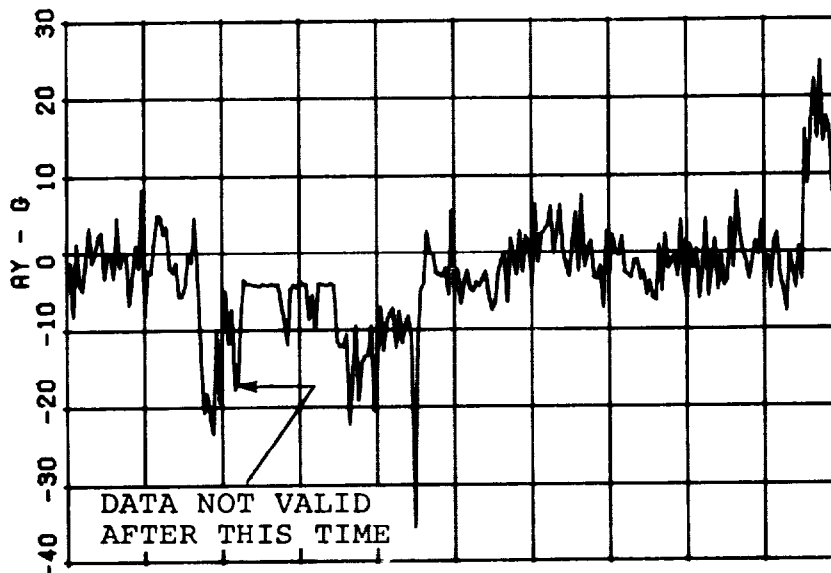
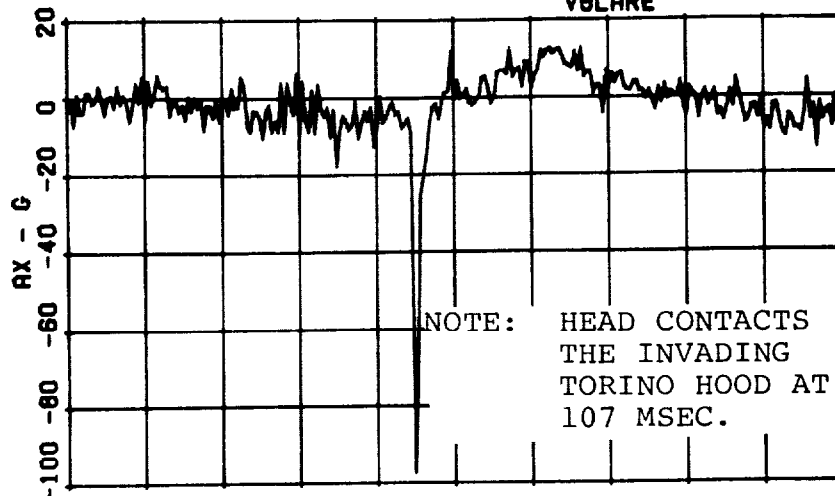
See note on page 25.

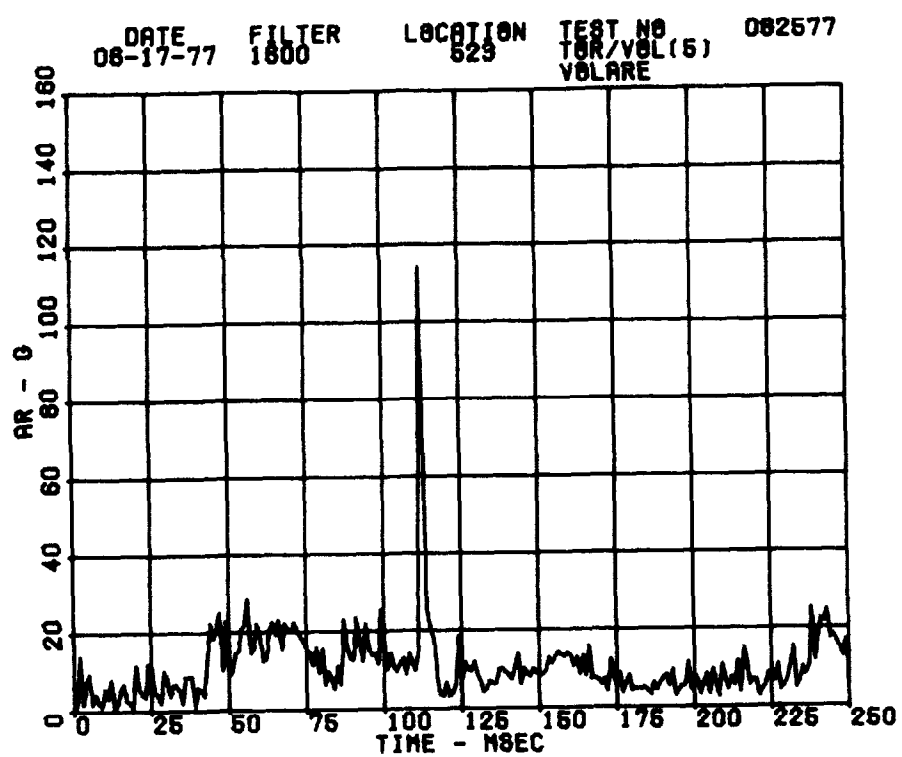


TASK 3, TEST 5
1976 VOLARE DUMMY DATA

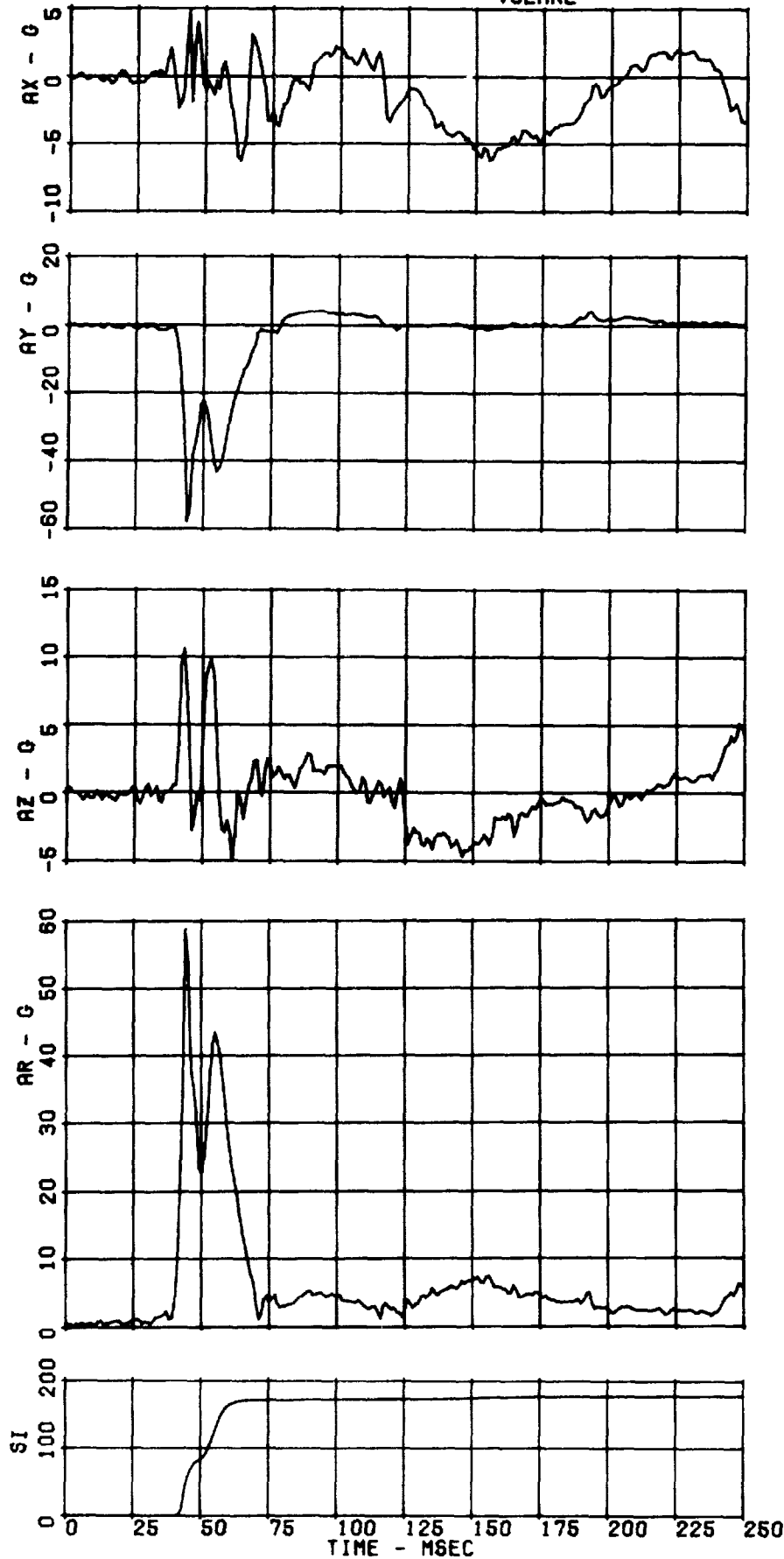
	FILTER CHANNEL CLASS	LOCATION IDENTIFICATION	
		<u>Right Front</u>	<u>Right Rear</u>
HEAD ACCELERATION	1000	523	526
CHEST ACCELERATION	180	1203	1206
PELVIC ACCELERATION	180	1603	1606

DATE 08-17-77 FILTER 1600 LOCATION 523 TEST NO 081777
 TOR/VOL(5)
 VOLARE

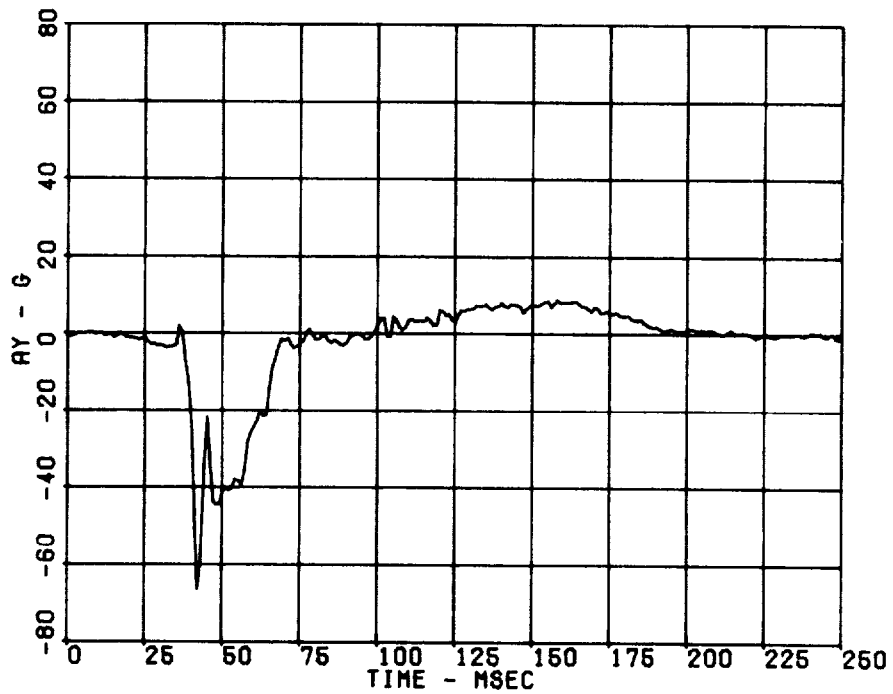
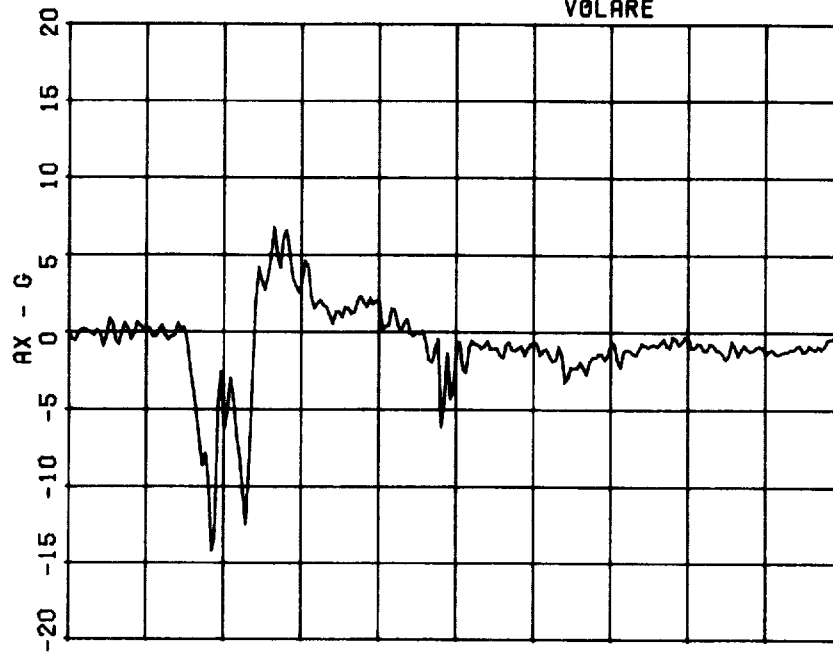




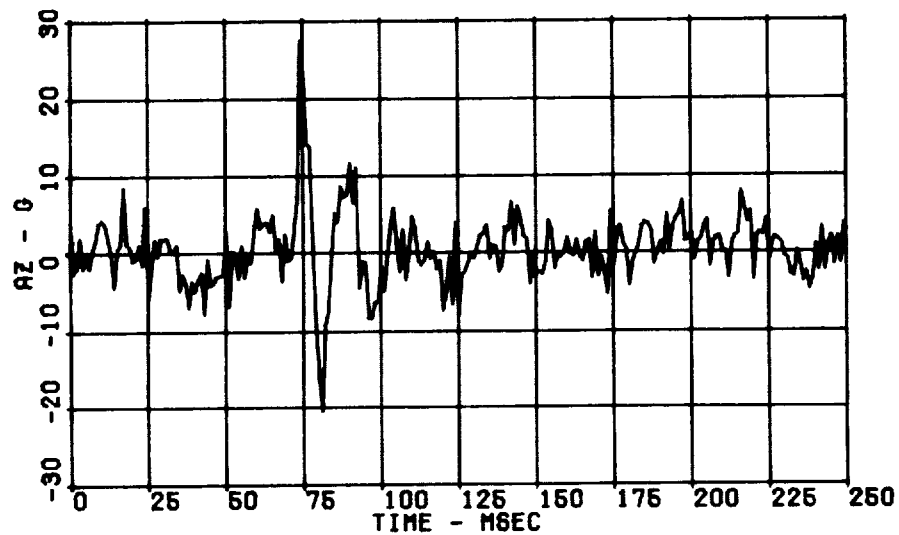
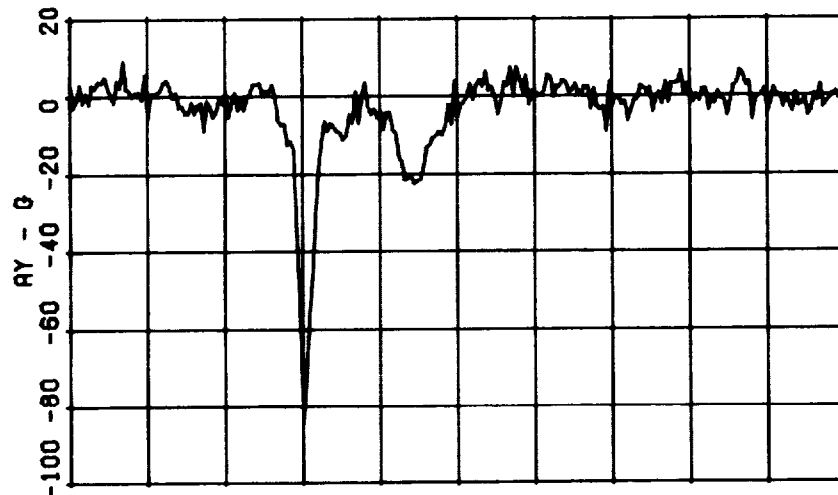
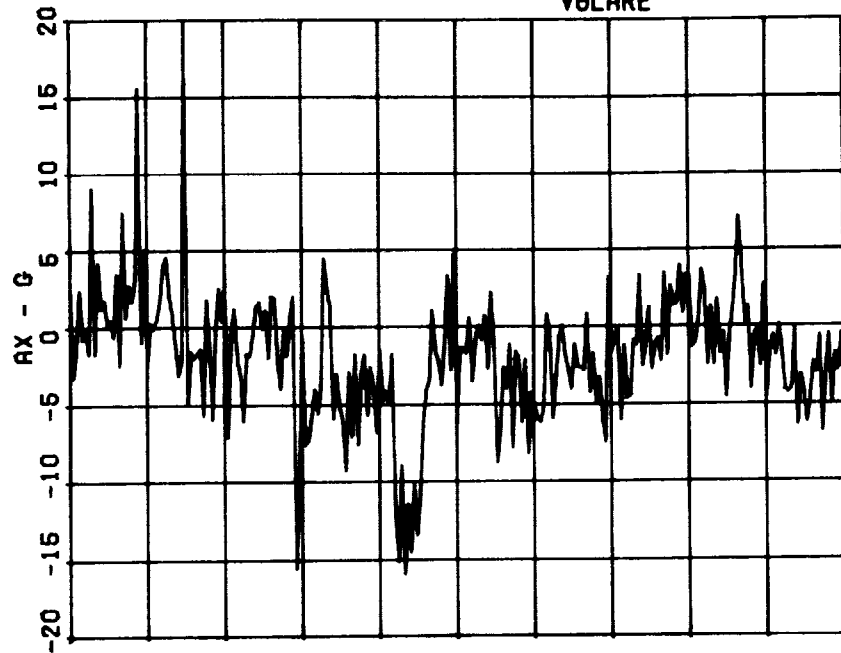
DATE 06-17-77 FILTER 315 LOCATION 1203 TEST NO 081777
 TOR/VOL(5) VOLARE

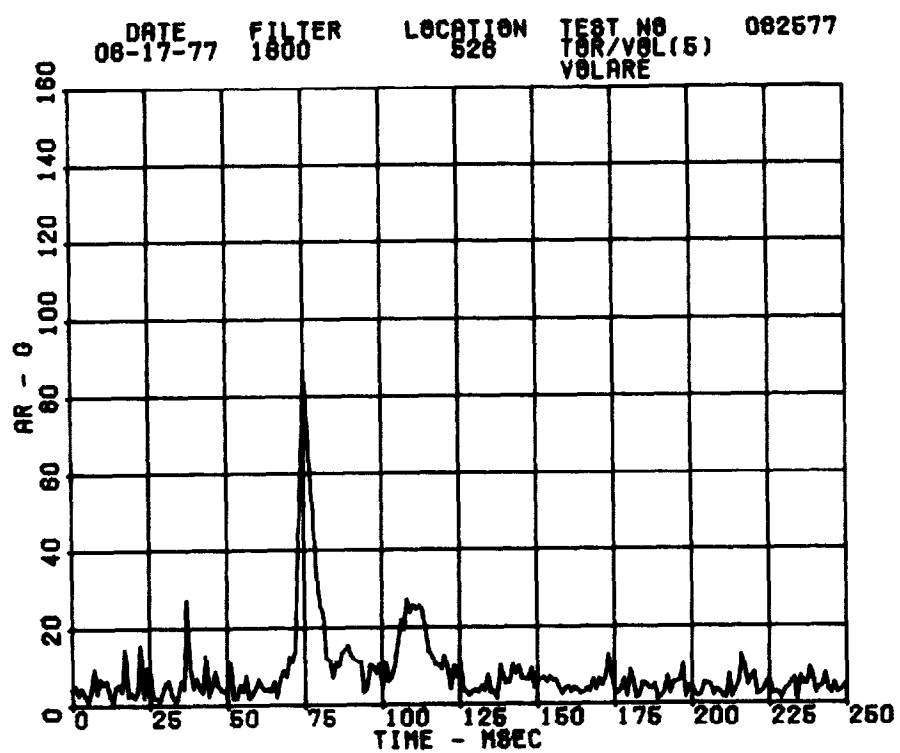


DATE 06-17-77 FILTER 915 LOCATION 1803 TEST NO 100777
VOL/TOR 5 VOLARE



DATE 06-17-77 FILTER 1600 LOCATION 526 TEST NO 081777
TOR/VOL(5)
VOLARE





DATE 06-17-77 FILTER 315 LOCATION 1208 TEST NO 092377
 VOL/TOR 5
 VOLARE

